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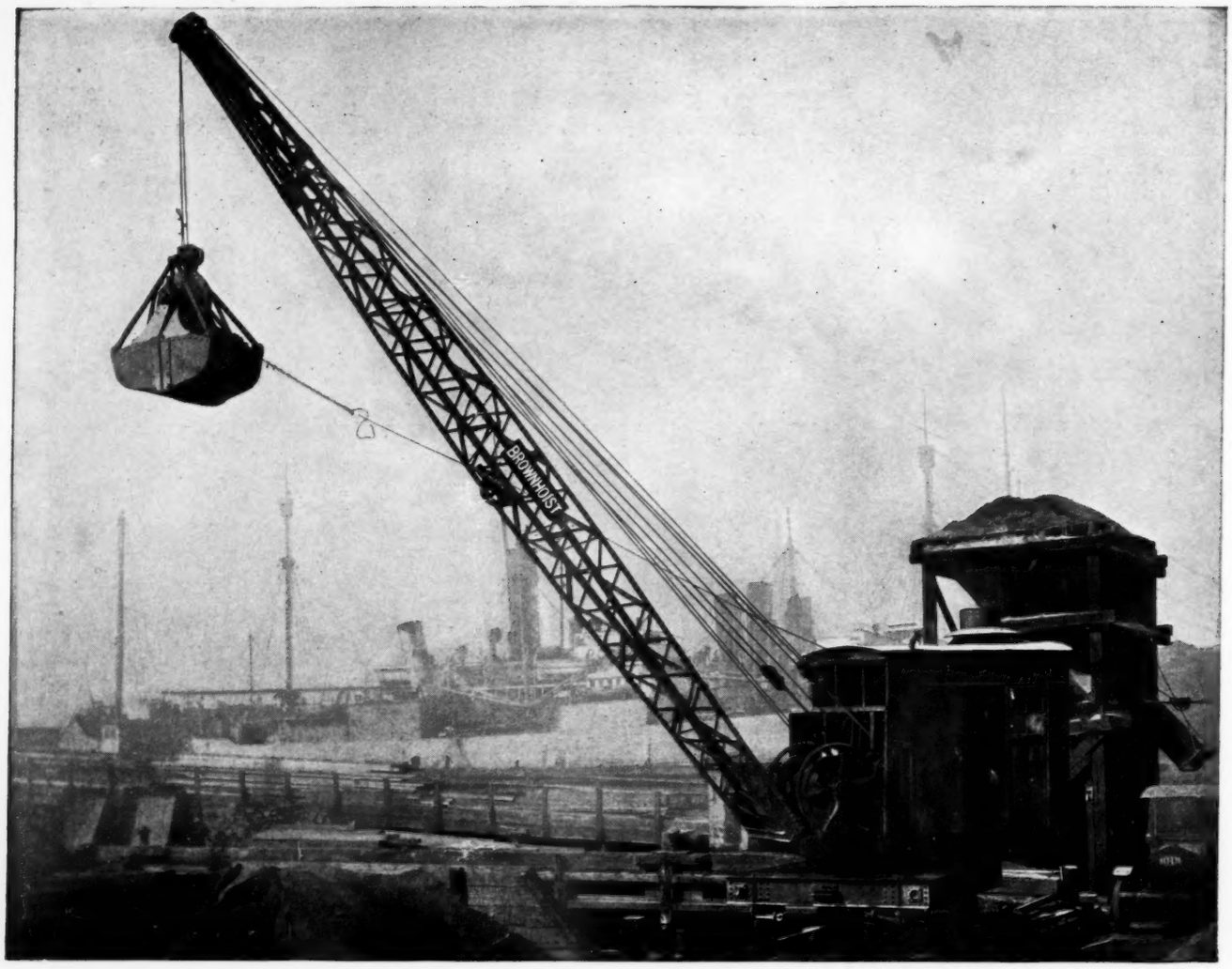

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PUBLIC WORKS.

CITY COUNTY STATE

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Liberty Tunnel, Pittsburgh

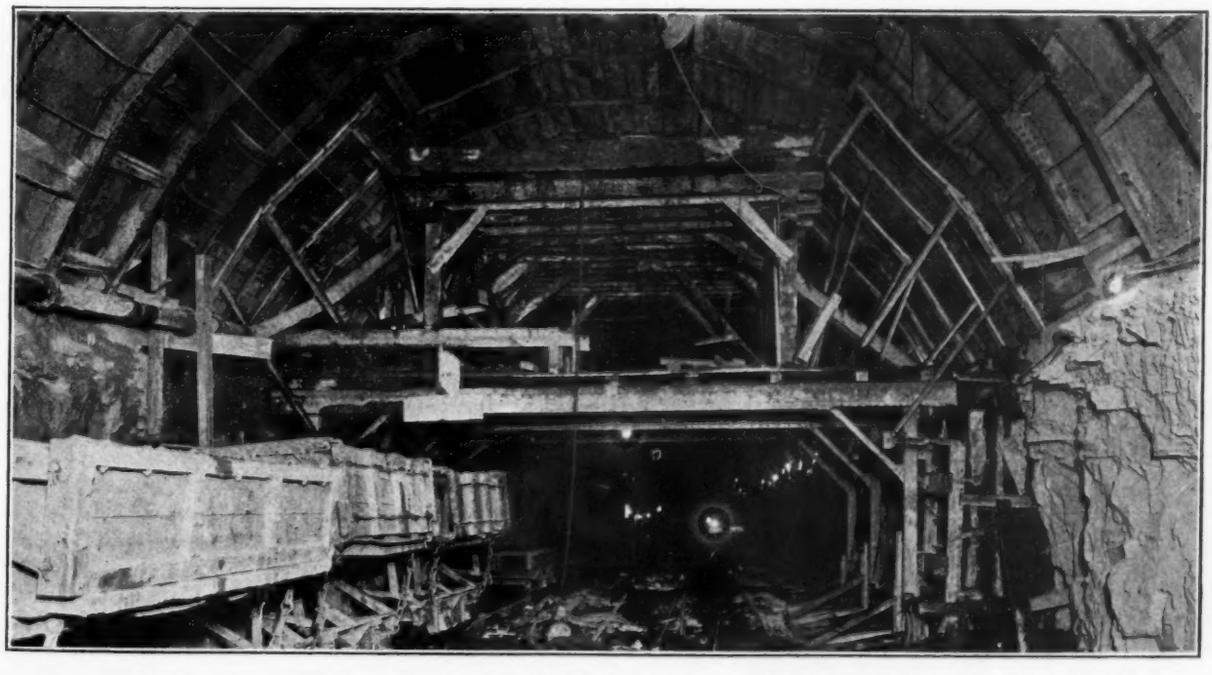
Construction of twin vehicular tunnels 26 feet wide, 5,750 feet long and about 350 feet below the surface. Long sustained record progress secured by ample drilling equipment, steam shovel mucking, improved concreting methods and an efficient force of 250 men in two full-size rock headings. About 12,000 yards of concrete and 24,000 yards of excavation saved by substitution of steel for wood timbering.

The Liberty Tunnel, Pittsburgh, now under construction through South Hills, will connect the business part of the city with the high-class residential district of West Liberty, Dormont and Mt. Lebanon, and adjacent suburbs, and is intended to be used exclusively for passenger traffic and the domestic supplies of the district served.

DESIGN

There are twin, concrete-lined, horseshoe-shaped tunnels, 59 feet feet apart on centers and about 5,750 feet long, with approaches extending the total length to 6,289 feet. Each tunnel has an electric railroad track, a 13½-foot driveway, and a 4-foot sidewalk, the driveway being intended for a one-way traffic of 1,690 vehicles per hour, moving 100 feet apart in two lines at a speed of 15 miles per hour. This is probably much more than will actually be realized for several years.

Under this traffic it is computed that there may be discharged into each tunnel 170 cubic feet per minute of poisonous carbon monoxide gas from the automobile engines, and that for its dilution to a harmless proportion it will be necessary to ventilate the tunnel with a supply of 280,000 cubic feet of fresh air per minute per tunnel. A system of ventilation has accordingly been devised to meet



WORKING PLATFORM FOR PLACING LAGGING ON BOTTOM FLANGES OF ROOF I-BEAMS

this requirement and the plans are now being completed to secure its operation in any efficient and economical manner. Such an installation will be of great interest and value in the case of other long vehicular tunnels where the disposition of noxious gases from automobiles is a serious matter, the proper treatment of which has not yet been practically demonstrated.

The tunnels were designed by and are being constructed under the direction of chief engineer, A. D. Neeld. Booth & Finn, Ltd., is the contractor. M. L. Quinn is the general superintendent, and John B. Sweeney, engineer. The work is being executed under a contract awarded by Allegheny county, December 2, 1919, at unit cost prices which amount to about $4,600,000, on the basis of the estimated amounts involved.

GENERAL CONDITIONS

Difficulty was experienced in securing a suitable disposal for the muck from the north end of the tunnel, so that operations were first commenced at the south portal only, and on June 22, 1921, the tunnels at that end had both been driven to a total length of 1670 feet from the portal. Plant has now been installed at the north portal also, and operations were commenced there about June 1st. The work is now progressing more rapidly than is called for by the schedule, and it is expected that it will be completed before the expiration of the time limit.

The tunnels are not driven, as has been published, through "good shale," but so far as they have been excavated, and according to indications for the remainder of the distance, are located wholly in green clay, red clay and soft laminated sandstone and for a short distanec through good blue sandstone, which is the only one of the different materials that is not very treacherous and dangerous to excavate.

FIRST TOPHEADING METHOD

The excavation averages about 33 feet in width and 26 feet in height, running 30 cubic yards per linear foot of tunnel. The two tunnels are parallel tangents and the headings are driven simultaneously and at about the same relative position in each tunnel. There is a uniform down grade of 0.392 per cent from the south portal to the north portal, but as little or no water is encountered there is no drainage difficulty.

As the blue sandstone disintegrated by exposure to the air, the quarry face at the south portal was safeguarded by removing the unsound rock and exposing the sound rock, which was covered with concrete 2 inches thick, applied by a cement gun. A portion of the rock base at the south portal having been undermined, it was supported by a concrete retaining wall 12 feet high and 30 feet long, which provided for the safety of the workmen and forms a portion of the permanent structure.

Work at the south portal was commenced on the 30-foot high face of an old blue sand-stone quarry. In each tunnel there were driven two 6 x 6-foot drifts, one on each side at the spring line, and a third drift of the same size at the crown. These were carried in about 30 feet and then connected by excavations about 6 feet high, reaching from the crown to each of the side drifts and exposing the rock surface of the whole tunnel roof, which was immediately protected by a permaent arch of 7 segments of 12 x 12-inch timbers set close together and under this roof "dumpling," marked 3 in the diagram, was removed down to the spring line, after which the remainder of the excavation down to the invert was removed in a single bench.

SINGLE WIDE HEADING AND HIGH BENCH

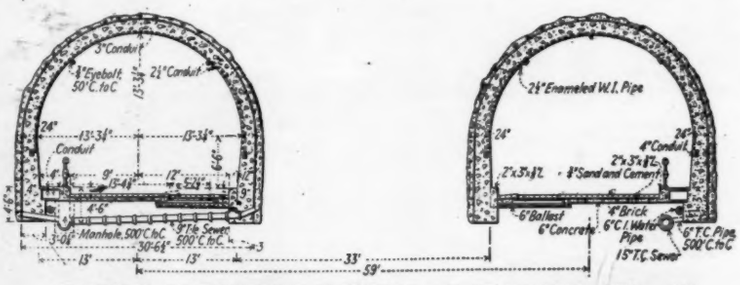
Beyond the 30-foot point the method was changed, and the tunnel was excavated with a full width heading 10 feet high and a single bench 16 feet high which was kept only 5 or 10 feet back from the heading, thus practically making the excavation in a single fullsize heading, the bench only serving as a convenient platform for drilling.

The heading is drilled with 45 holes, 15 feet deep, and the bench has channelled sides and 12 vertical holes. The rock is blasted with from 1½ to 2 pounds of 40 per cent dynamite per cubic yard of excavation. Drilling and shooting is done at night by a gang in each tunnel working an 8 to 10-hour shift. The mucking is done by mucking gangs in the 8 to 10-hour day shift. The system of working only two shifts allows for either to overlap in case of necessity. In some cases as much as 7 hours have been lost in one shift by a breakdown of the steam shovel and regained in the same 20-hour day by concentrating in this heading the muck cars and locomotives from the other tunnel.

The muck is handled by a No. 41 compressed air operated Marion steam shovel with a 1½-yard bucket in each heading that loads the 4-yard heavy-duty Western side dump cars that are hauled in 5-car trains to the south portal by electric locomotives and thence to the McKinley City Park by one Climax geared locomotive and three Vulcan locomotives. After the completion of this fill it is intended to deliver the muck for use in the foundations of the Knoxville boulevard, which will thus be built up to a height of 35 feet without cost to the city.

AIR SHOVEL MUCKING

As fast as the tunnel is driven there are laid on the invert two 36-inch service tracks with 80-pound rails. On one track there is maintained at the head-



SECTION OF LIBERTY TUNNELS AT MANHOLE AND AT INTERMEDIATE POINT

SOUTH PORTAL EXCAVATION AND GROUTED ROCK OVER EAST TUNNEL HEADING

ing an electric locomotive and train of empties and full cars, both of them close to the air shovel that is located between the two tracks. The two tracks are connected by a switch in the rear of the shovel, and as fast as a car is filled the 5-ton locomotive pulls it back, moves an empty up to the shovel beyond the switch, and returns to the opposite side of the switch, permitting the other locomotive to cross the switch and haul the full car to the opposite track, and so on until the entire train has been loaded in about half an hour, without any lost time for the shovel.

ROOF SUPPORT

Blue sandstone has been encountered only for the first 300 or 400 feet from the south portal; the remainder of the excavation has been, since then, through very treacherous material that rapidly decomposes by exposure to the atmosphere, so that the roof requires to be supported immediately, and if there are indications of falling before the permanent timbering and lagging can be put in it is temporarily posted to protect the workmen.

Wood timbering was used only for the first 30 feet of tunnel next to the south portal. In the remainder of the work 12 x 12-inch arch segments have been replaced by 8-inch 32-pound H-beams of the same length, weighing about 200 pounds each, that are bolted together with two web plates and one inside flange at each joint. They support 3-inch wooden longitudinal lagging strips. The voids outside of the latter are carefully filled with selected sandstone, hand packed. The lower ends of the bottom segments of each bent are seated on steel bearing plates that in turn rest on bevelled blocks fitted into the side walls, except in occasional cases where the rock is not sound or has been blasted too far away, when wooden vertical posts are provided.

The H-beams, set from 2½ to 5 feet apart on centers, are considered very economical and satisfactory and develop enormous strength if the latter is computed from a deflection of 3 inches in a 7-foot span, which gives a maximum stress of 25,000 pounds per square inch in the flanges, which is safely carried. The use of H-beams for this purpose is believed to be unprecedented and they are considered stronger with a spacing of 5 feet on centers than are 12 x 12-inch wooden timbers 3 feet apart on centers.

Steel was adopted, both on account of the excessive cost of timber (about $65 per thousand feet B.M., unframed) as compared with the cost of the H-beams cut to length at the mill, and because of the very important saving of 2 yards per linear foot in the rock excavation and one yard per linear foot in the concrete lining for each tunnel, items that together amount to a large sum for the completed tunnel.

Where wooden timbering is used it is required to make the excavation large enough to keep the timbering entirely outside of the neat line of the concrete work. The steel H-beams however are classified as reinforcement for the concrete lining and are allowed to project inside the neat line into it, thus reducing the dimensions of the cross sections of both the excavation and concreting, by an average amount of about 10 inches around the entire circumference of the tunnel above the invert.

CONCRETING

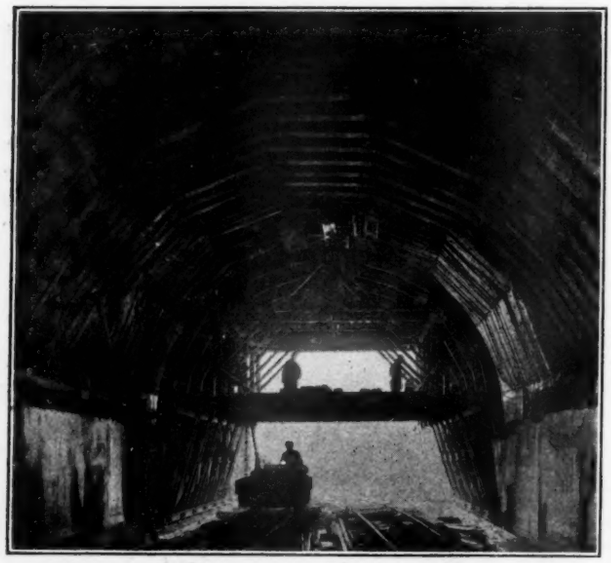
Aggregate, delivered over a spur of the railroad track, is stored in a 1,000-ton hopper-bottom bin of seven compartments, with a cement house on top at the track level. The bins discharge by gravity into a measuring car on a track underneath. The cement is spouted in 4-bag lots through an 8-inch pipe to the car. The car descends by gravity on a 4 per cent grade to the 4-bag Ransome mixer and

SIDEWALLS AND FORMS AND TRAVELING INCLINE FOR CONCRETE CARS

is hauled back empty by a Little Tugger hoisting engine operated by compressed air.

The mixer is at present operated at the rate of about 1,800 cubic yards per week, which is discharged into 36 1½-yard cradle-dump cars of the Lakewood and Koppel types, lowered by a hoist to the tunnel grade 600 feet from the portal, and then hauled by electric locomotives in 7-car trains to the forms, where they are drawn up an incline to the level of the spring line and dumped directly into the forms for the side walls.

Concrete for the arch is delivered to a Caniff-Ransome pneumatic conveyor machine under the platform, and is then delivered through a 6-inch pipe of a maximum length of 100 feet with two long radius bends, to the level of the crown of the arch, where it is discharged through a two-way tee to both sides of the arch and is so thoroughly spaded that it is very compact and no finishing is found to be necessary when the forms are stripped. As the concreting approaches the crown the tee is removed from the end of the discharge pipe and



ERECTING STEEL FORM FOR ARCH CONCRETE, WEST TUNNEL. NOTE ROOF I-BEAMS

the concrete is delivered directly against the face of the key, about 2 feet wide, as the pipe recedes from the concreted arch.

The separate side wall and arch forms about 30 feet long were designed by Mr. Sweeney, approved by Mr. Neeld, and manufactured by the Blaw-Knox Co.

The tunnel is required to be waterproof and after the contractors and the membrane waterproofing company had worked for many weeks without success to devise proper methods of applying membrane waterproofing, the attempt to use it was abandoned, and the engineer imposed the alternative of grouting the roof and walls under 300 pounds pressure applied through seven 2-inch pipes installed in every 15 linear feet of the tunnel. The lining is accordingly grouted with a Cockburn Barrow machine as soon as convenient after the concrete has satisfactorily hardened.

RAPID PROGRESS

The excellent planning and organization together with the amount and quality of construction equipment installed and the efficient direction of the work have enabled the contractors to establish a new record for tunnels of this size and character, maintaining a progress of 10 feet per day continuously for 6 days a week for the months of March, April and May, last, when there was an average of 620 yards of muck removed in two shifts every twenty-four hours.

These results were undoubtedly promoted by the policy of encouraging the men, who were allowed 11 hours pay for 9 linear feet of tunnel and 12 hours pay for 10 feet, no matter how quickly the work was actually done. They were also provided with a black flag and an American flag, the first shift out of the tunnel having the privilege of displaying the American flag the following day, while the other shift was required to display the black flag.

Besides the equipment already mentioned the contractors have installed 65 Ingersoll jackhammers and 6 Waugh hammer drills, 3 Ingersoll Rand Imperial type air compressors, direct conected with electric motors, two direct connected 60-cycle 2-20, three-phase Westinghouse generators for the electric locomotives.

The principal quantities involved include the rock excavation in the tunnel, 127,000 yards of rock excavation in the approaches ,about 9,000 yards of concrete in the portals and retaining walls, concrete in the tunnel lining, about 220,000 pounds of reinforcement, 6,600 square feet of brick and 1,575 square yards of stone block paving in approaches, 12,640 square feet of sidewalk in approaches, about 1,000 cubic yards of concrete in an arch span in the approach, and about 2,000 sets of H-beams having a total weight of about 2,800,000 pounds.

The contract price per linear foot of tunnel is $722, of which the specifications provide that an estimate of 45 per cent shall be made when the work is ready for the masonry lining up to an elevation of about 3 feet above the spring line, 19 per cent for the excavation below the heading excavation, 26 per cent for the masonry lining including the terra cotta and wrought iron conduits, 3 per cent for paving, and the remainder for various small items. Ten per cent of the whole is retained until the final estimate and acceptance of the finished work.

More Hydroelectric Power For Alabama

The Alabama Power Company furnishes a large part of the electric energy used throughout the state and has been a conspicuous factor in the development of the state. Practically all of the power that the company is able to furnish with its present facilities is being utilized and it is now preparing to construct another dam at Duncan's Riffle on the Coosa river in order to add greatly to the amount of power that it can furnish. The Federal Water Board has given the company the necessary permit and the company has borrowed $25,000,000 for carrying out the construction. It is stated that the construction of the dam will require the employment of

1,500 to 2,000 men for a period of eighteen months or possibly two years, and that work will be started at once.

Jamestown's Municipal Milk Plant

Last year, as stated in the September 25th issue of PUBLIC WORKS, the taxpayers of Jamestown, New York, voted to bond the city for $150,000 for the construction of a municipal plant for pasteurizing milk and distributing it to the inhabitants of the city, having obtained about four years previous a special act of the legislature specifically authorizing it to issue bonds and operated a municipal milk plant. The project has been held up because attorneys for the bond buyers have raised the question as to constitutionality of the proposed innovation and consequently the city has been unable to sell the bonds and begin the proposed undertaking. Mayor Samuel A. Carlson informs us that it is expected that steps will be taken very soon for a friendly suit to test this point.

Baltimore's Public Works

Results obtained and put under way during the past twelve months in the water works and highways departments.

In 1918 the State Legislature extended the limits of the city of Baltimore to enclose nearly three times the area of the city as it had previously existed, or from 32.19 square miles to 91.93 square miles. There has been published in the June 10th issue of the "Baltimore Municipal Journal," the official city organ, a resume of the work done by the present administration, which has been in power since that time. Certain of the more interesting and important items of this report are given in the paragraphs below.

Politics prevented securing department heads in sympathy with the aims and aspirations of the administration for the first six months, but finally council co-operated and confirmed the various appointments. One June 1, 1920, Henry C. Perring was appointed chief engineer of the city, a position that had been vacant for several years, and took office immediately. Mr. Perring heads the Department of Public Improvements and as such has aimed to secure the hearty co-operation of all the various subdepartment heads. The various branches of the public works are placed in charge of the Public Improvement Commission, which has jurisdiction over the expenditure of a $15,000,000 loan for water works and a $26,000,000 loan for schools, paving, bridges, sewers, conduits, harbor, police and fire protection. The Port Development Commission is spending $10,000,000, with an authorized loan of $50,000,000, for the general development of improvement of the harbor. The board of school commissioners, paving commission, electrical commisssion, highway engineer's department, water department, harbor board, law department, fire department, health department, board of park commissioners, city service commission and others have charge of the different services indicated by their titles.

WATER WORKS

The largest single project authorized and undertaken by the public improvement commission is that of the Loch Raven dam and the other water works construction connected therewith. As already noted in PUBLIC WORKS, it is proposed to raise this dam 52 feet above its present height, which will increase the storage to 22,000,000,000 gallons, which is ten times its present capacity, and will supply sufficient storage for the needs of the city for the next 25 years. The Gunpowder river is the sole source of water supply for Baltimore and with the recent rapid growth of the city the municipality was threatened with a water famine because of the insufficient storage, although the flow of the river is ample. Messrs. Hill and Fuertes, consulting engineers, made recommendations some time ago covering the supply of Baltimore for the next hundred years and the work now under way is the first step of the program they recommended.

The city has just completed negotiations for the purchase of the Baltimore County Water and Electric Company for $2,598,335. This company has supplied water to a considerable part of the territory recently annexed.

"The water department last year began a drive for conservation and as a result of the methods undertaken to stop leakage and waste, a great saving has been effected. This may result in the postponing of the extension of the filtration plant which would involve a capital expenditure of $1,250,000, and additional operating costs. The survey of underground leakage is now in progress, in addition to the inspection of plumbing fixtures in houses."

As a result of the progress so far made, the consumption of water has been reduced about 20 per cent and millions of dollars have been saved to the city. Last year a 30,000,000 gallon centrifugal pump was installed at the Mount Royal pumping station and the tests indicated that it is perhaps the most economical pump of its size that has been built in the United States.

HIGHWAYS

The highway engineer's department is divided into the divisions of sewers, highways, permits and bridge and improvement. A program of sewer extensions totaling $2,500,000 has been approved for this year. It is unlikely that this amount will be expended before the end of the year. Since January first, 1920, this division has built 27 miles of house sewers and 12 miles of house connections, 8 miles of storm water sewers and 2 miles of clear water drains.

The highway division has charge of repairs of the highways, but not of new paving. Since May, 1919, over one and a half million square yards of repair paving have been laid and in addition 936,000 square yards of roadway has been resurfaced. Under the emergency labor program, when the wave of unemployment was at its highest, about 500 men were put to work spreading cinders on some of the roads

which were complained of as being in bad condition and about 40 miles of roadway 20 feet wide were so covered.

Of new paving comparatively little has been done during the past few years. A $5,000,000 paving loan approved in 1911 was expended by 1916. From then until 1919 a system of borrowing in anticipation of the collection of the special paving tax was employed but could not be continued after that date. Add to this the increase by about 100 per cent of the cost of paving in 1920, and the slowing down of the paving program is easily accountable for. During 1919 and 1920 the paving commission laid about 19 miles of pavement at a cost of $1,675,000.

"One of the innovations of this commission is the so-called fifty-fifty agreement which was originated by the Board of Estimates, under which the developer of a tract of land must pay one-half of the cost of paving new streets in his development. This agreement was recently amended to impose upon the developer the obligation of reducing his streets to grade before the city will undertake the paving even under the fifty-fifty agreement."

The paving program for 1921 includes about 25 miles of streets and alleys, and contracts totaling $825,000 have been let in the first six months of this year and 6 miles of paving have been actually completed.

One of the results of the co-ordination in the development of public improvements is the putting into effect of a plan for giving advance notice of contemplated paving and requiring that all underground improvements be completed before the pavement is laid. This has ended the evil of tearing out new pavements for the installation of water mains, conduits, etc.

MUNICIPAL EMPLOYMENT BUREAU

During the winter of 1920-21 thousands of men were thrown out of work in the city. This condition had been anticipated and a municipal employment bureau had been established by a committee appointed by the mayor. The city, in order to employ the men, undertook improvements which, while necessary, were not urgent and could have been done at a later date. The men were paid only 30 cents an hour, but the low wage scale was justified by the fact that they could not, on account of weather conditions, give greater value to the city by their labor. Thousands of men were given employment and the program was approved generally. This bureau is still in existence and will probably be maintained as a permanent institution.

California Sub-grade Experiment

Following the report of the Federal engineers which called attention to the injurious effect of an adobe or alkaline sub-grade on the thin concrete pavements laid by the State Highway Commission of California, that commission has been conducting experiments on the road between Mojave and Lancaster, with the use of oil applied by the penetration method to the sub-grade, with a view of insulating the concrete from the alkali in the soil. On another section of the highway, where the soil is adobe, the engineers are placing a 4-inch cushion of gravel over the sub-grade. Similar experiments are being conducted west of Lemoore in Kings county.

Some of the oil macadamized highways built by the San Joaquin county are to be widened by the State Highway Commission by building a 30-inch concrete shoulder about 8 inches thick on each side of the existing pavement, which will be scarified and re-rolled and re-surfaced with asphalt concrete to an aproximate thickness of 2½ inches. About $20,000 is to be spent on this experiment.

Bureau of Municipal Research

The New York Bureau of Municipal Research has ceased to exist, having been combined with a new corporation known as the National Institute of Public Administration. This institute plans to train men and women in the practical work of public administration. The acting director is Luther Gulick, Clarence B. Smith, Jr., is manager and Raymond B. Fosdick is counsel. The names of men well known in the field of municipal finance, engineering, public health, city planning, etc., are listed as instructors, lecturers and consultants. The office of the institute is at 261 Broadway, New York.

Mile of Concrete Pavement a Week

Work on a 21-mile contract, done from a central mixing plant with a record of 1,694 square yards in one day, and from a central proportioning plant, delivering 36-cubic-yard train loads of cement and aggregate in 2-yard batch boxes.

In the construction of 21 miles of the Joliet-Morris 18-foot concrete highway, which is a part of the Federal Aid road between Chicago and St. Louis, the Powers-Thompson Construction Co., contractor, has installed equipment for simultaneous prosecution of the work from two points, at which central mixing and central proportioning are carried on under similar conditions, making valuable comparative results.

Although the alignment generally has few curves and light grades, there was considerable excavation to be done and the coarse grave' was handled by elevating grader machines. Sand and gravel are obtained from a large local gravel pit with a short haul that eliminates freight charges. Concrete is proportioned 1:2:3½. Operations were commenced in September, 1920, and eight miles of road were completed that season when a record progress of 837 linear feet of road was made with one of the two plants, involving a haul of about one mile for the mixed concrete.

The work is being prosecuted from two central plants, at one of which there is a Koehring 28-E mixer installed near the plant of the Chicago Gravel Company. At the other plant elevated sand and gravel storage bins, adjacent to a railroad track, deliver the aggregate for distribution dry to the paving machine that is working toward the other plant. Both the central mixing plant and the central proportioning plant can be shifted if necessary as the work progresses and the hauls become too long for them.

At the central mixing plant the concrete is discharged to six large trucks rented from the State of Illinois, that haul it over a good road to the required point, with a record for hauling 290 batches about 1 mile in one 8½-hour day, last fall. This season a record has been made for hauling 200 batches five miles in one day, thereby laying 630 linear feet of pavement as compared with the 847 linear feet last fall, with the one-mile haul.

At the other plant the aggregate is delivered from bins into 2-yard Western batch boxes, loaded in pairs on the trucks of Western 8-yard dump cars from which the boxes have been removed. These are hauled in 7-car trains by 12-ton locomotives, except at a long 4 per cent grade where the trains are split and three of the cars are hauled up the grade by a 5-ton truck, after which the remaining four are hauled up by the locomotives, which takes the whole train to its destination. After the proportioning plant has been moved beyond this grade, 9-car trains will be hauled by a single locomotive.

The batch boxes are unloaded and the paving mixer is hauled along on the subgrade by a Bucyrus crane mounted on crawler traction. The mixing machine is handled by one operator, and one assistant and two men puddling and spreading concrete; besides which there is one man to handle the crane, one to handle the finishing machine and the others for preparing subgrade, setting forms, covering and screeding the concrete and other miscellaneous work.

The Meridian International Highway

Early this year, D. E. Colp, of San Antonio, and Fred W. Mally, of Laredo, Texas, officials of the Meridian Highway Association, in conjunction with the Department of Communications and Public Works of the Republic of Mexico, began a campaign to extend the Meridian highway from the Rio Grande to Mexico City.

In the United States this highway begins at Laredo, on the Rio Grande, and extends northward to Winnipeg, Canada. Through three-quarters of Texas the road either has been paved or is under construction. In Oklahoma, bridges crossing the Canadian river have been built or are under way, and in South Dakota the bridge crossing the Missouri river is under construction. North of Texas all of the highway has been graded and much of it has been graveled or paved. The highway has been "signed" for the entire distance, and with the completion of the work being done this year and the bridges, it will be open for traffic from the southern to the northern boundary of the United States.

In Mexico the Obregon administration, through the Department of Commerce and Communications, is enlisting the interests of the state governments and co-operating with them for the continuation of this road to Mexico City. At the invitation of the Mexican government a party of 14 United States citizens visited Mexico City in May, stopping at several of the principal cities along the proposed route of the highway. This party included Mr. Colp, the vice-president of the association; Mr. Mally, secretary of the Laredo chamber of commerce; and G. A. MacHaughton, the Texas secretary of the association; also the entire state highway commission of Texas, with others from Oklahoma, Nebraska and South Dakota. Ben Baines was assistant secretary and E. A. Kingsley was engineer for the party. Two engineers of the Mexican Department of Commerce and Communications and two officials of the Mexican army acted as escort to the party.

On its way to Mexico City it stopped at Monterey, Saltillo, San Luis Potosi and Queretaro; at each of these, conferences were held with the governors of the four states in which the several cities were situated and in addition representatives from other states joined the party for conference.

At Mexico City the secretary of the Department of Communication and Public Works, Faustino Roel, outlined his plan for a system of interstate highways that would link into the United States highways at Laredo, Brownsville and El Paso. He assured the delegation that the Mexican government was thoroughly in earnest regarding the development of a system of national highways and obtaining at least one international highway. The various Mexican highways would all lead to Mexico City. The Mexican government believes that the construction of good roads throughout that country will facilitate the rapid movement of the rural police and eventually eliminate the bandit curse.

Much road construction is now being done by the various Mexican states and by the national government. Some of this is of a permanent nature and some merely grading and graveling. All culverts and bridges built are of permanent construction types. Grades and road widths are planned for the future and for ultimate permanent work. The Mexican highway engineers are men of much ability and are doing excellent work. Many of them received all or part of their education in colleges of the United States. Jorge Nunez, one of the engineers who acted as host to the party, is a graduate of the University of Pennsylvania.

The visiting Americans were conducted to various sections of the country convenient to the capital and were impressed with the amount of building that was going on, factories being installed and the changes in the educational methods, free public schools being installed and education being made compulsory. They were also impressed with the fact that there was no animosity felt towards citizens of the United States, but that a feeling of cordiality was everywhere apparent.

Laying and Repairing Six-Inch Submarine Pipe*

By James W. Graham

Wrought iron pipe was laid in Portland harbor by scows. Later it was broken by an anchor and was repaired with great difficulty.

Peaks Island is located in Casco bay about two miles from the city of Portland, Me.

The water supply for the island has for some years been obtained from driven wells, but during the summer of 1919 the wells did not furnish sufficient water to keep the higher parts of the island supplied.

The population of the island in the winter is about 1,000, but in the summer season it reaches 7,000 and on holidays is perhaps 10,000. The wells supply ample water for the winter population, but the need of more water during the vacation season was apparent.

The city has an abundant supply of excellent water, but the cost of carrying it to the island by the ordinary method of flexible-joint cast-iron pipe was prohibitive. It was therefore decided to lay a six-inch galvanized wrought-iron pipe of standard weight, using recessed couplings. At sharp changes in the grade, Moran flexible cast-iron joints were installed.

The bottom of the harbor on the route selected was soft, blue clay and silt for a considerable part of the way and, except where the tide had carried away the silt, the pipe would sink about a foot and a half into the mud. In some places, where the clay was fairly hard, the pipe lies on the mud, exposed to the sea water.

As fresh water freezes at 32 degrees and salt water at 27 degrees, and each winter the water in Portland harbor reaches 28 degrees, it is a question yet to be decided whether this line can be maintained in operation throughout the year. It is feared that enough of the line may be exposed to the flow of sea water to reduce the water inside the pipe to 32 degrees.

There was no ledge on the selected route except on the land sections; and no logs or other obstructions, so that the pipe was well supported along its entire length.

The line adopted left the east end of the city on an easy grade so that 1,800 feet from shore there was only ten feet of water at low tide. The next 1,600 feet was a ship channel having 30 feet of water at low tide with gently sloping side banks. Beyond this channel the pipe reaches a part of the bay where for 5,200 feet the depth of water varies between 10 and 17 feet at low tide. Next comes a channel 30 feet deep and 800 feet wide and then the flats leading to Little Diamond Island. The line then crosses this island for 1,500 feet and rises to a height of 40 feet. Between this island and Peaks Island is 2,500 feet of water reaching a depth of 25 feet with gently sloping banks.

The rise and fall of the tide in Portland harbor is 9½ feet, so that a part of the line was laid in 40 feet of water.

The total length of submarine pipe is 12,025 feet, or about 2¼ miles.

For the purpose of laying the pipe, a flat-bottom scow was engaged. The boat was 26 feet wide and 56 feet long and draws about 3 feet of water when carrying no load. The sides stood 3 feet out of water and it was decked over. It carried a mast with derrick boom and a steam hoisting engine forward and had a cabin in the stern. Stanchions at each corner were very useful for fastening anchor lines.

A small tug was used for transporting the crew and moving the anchors used for holding the scow in position.

The crew consisted of an engineer and deck hand on the scow, one man on the tug, three seamen, five pipemen and a foreman.

It was desired to begin the construction of the line as early in the spring as possible, but the prevailing wind storms during April held back the beginning of construction until about May 1, 1920.

In beginning the work, as much pipe was put on the deck of the scow as was possible without interfering with the working deck space, and still more was stored in the hold. The scow was then towed around to the point of beginning on the shore of the city.

Four 600-lb. anchors were provided, two having 1,200 feet of 3½-inch manila rope each and two having 600 feet each of the same rope. Each anchor had a 75-foot drag line with a wooden float attached to one fluke.

The tow boat carried an anchor several hundred feet off from each corner of the scow and dropped it to the bottom. The scow was held in position by these four anchors, one leading from each corner, and was pulled in the desired direction by passing the proper anchor lines to the steam winch. When it was desired to move the anchors, the tow boat would pick up the float attached to the fluke of the anchor and by pulling the line up short had no trouble in dragging the anchor to the desired position.

At high tide ten twenty-foot lengths of pipe were dropped overboard near the high-water mark and at the following low tide the pipe was screwed together and left lying in position on the mud with one end at half tide.

The following high tide the scow was pulled near the low water end of the pipe and the end of the pipe was raised to the deck of the scow. (The scow lay at right angles to the line of the pipe so that the work was done near her center. When she was pulled ahead she went sideways.) The next piece of pipe was then screwed into the line with a 6-foot chain tongs. It was screwed up to refusal with five men on the tongs, and the pipe threads out of sight within the recessed coupling. Each end of the coupling was then painted with red lead and oil.

*Paper before American Water Works Association.

The scow was then pulled ahead 20 feet and another piece of pipe inserted in the line.

When the depth of water became greater than 15 feet, a rope was passed under the pipe and over a plank lying across two dories. On this plank was a cleat to allow the pipe to be easily lowered. When the depth of water exceeded 25 feet, two sets of dories were used. The distance between these supports was about 150 feet.

The pipe was left suspended to the scow and dories at night when the wind did not blow hard enough to rock the scow to any extent, but in rough weather the pipe was lowered to the bottom and picked up the following morning. We were not forced to lower the pipe and pick it up again in the deeper parts of the line.

When the scow finally approached the island shore, the pipe was laid in the regular way at high tide to a point well above low water and at low tide, men working on the flats connected up additional pipe. When the pipe end was lowered into the water it was carefully plugged in order that no water might get inside.

The work was carried on the same way between Little Diamond and Peaks island. The distance was 2,500 feet and the water was comparatively shallow.

The wrought iron pipe was carried up to a point near half tide, where it was connected to cast iron pipe by a cast iron sleeve. Those parts of the line crossing Little Diamond island and on Peaks Island and in Portland necessary to connect with existing mains were laid with cast iron pipe.

The line crossing Little Diamond island, about 1,500 feet in length, was laid on the surface of the ground and the joints were made of "lead-hydro-tite." It took two days for our men to learn to handle this compound, and then the work proceeded smoothly. It became evident that a gasoline burning furnace built especially for melting this material was very essential and would pay for itself in a short time.

After the entire line was installed and had been working a few days, a two-inch Empire meter was installed at the Portland end on a by-pass and the gate at the far end was closed over night. All water entering the line passed through the meter. The reading of the meter the following morning showed that the line was perfectly tight, the meter not having moved.

In October it was decided to bury the land portions of this line below frost. This involved lowering the 1,500 feet across Little Diamond island, a part of which was ledge. This was accomplished by making the trench along side the pipe line, and the blasting was done without disturbing the line. The pipe was then lowered into the ditch a little at a time without shutting off the water for more than an hour or so.

The lead-hydro-tite joints stood this moving successfully. A few of them leaked a little when first lowered, but the ditch was left open for a few days and the leakage stopped.

On the shore of Peaks island a 6-inch Empire compound meter, a 6-inch Ross pressure regulator, and a 6-inch check valve were installed with proper by-passes. On Peaks island is a standpipe with the overflow at an elevation of 135 feet above the tide water. On the Portland end, the supply for the line was equal to a head of 250 feet above tide.

The Ross regulator was set to close when the water in the standpipe was 3 feet below the top and during the night the submarine part of the line was subject to a pressure of 280 feet.

When the water was first turned into the Peaks island system, it happened that the wells had been pumped nearly dry, the standpipe was empty and only the low parts of the system were getting water.

The head on the island end was equal to about 30 feet when we turned the supply from the city into the island system.

The meter showed a flow for the first few minutes at the rate of 600,000 gallons per 24 hours. The total length of this 6-inch line was 14,050 feet. The loss of head in the line when first turned on was 220 feet. This gives a value of C in the Williams and Hazen Tables of 125.

The 12,025 feet of wrought iron pipe was laid in 22 working days, an average of 546 feet per day. The best day's work was 1,160 feet in 10 hours. The poorest day's work was 150 feet.

The total cost of the entire 14,050 feet of main was $38,400. This included burying the cast iron pipe below frost, legal and engineering expenses and all overhead charges. The direct cost of the submarine part of the line was $26,125 for 12,025 feet, or $2.17 per lineal foot.

The cost of the pipe delivered in Portland was $1.56 per foot, leaving 61 cents per foot for the cost of the fittings and laying the pipe.

On Tuesday, November 2, 1920, there was a heavy storm with a high wind at Portland. A large steamer lying at anchor nearly a mile from the pipe line dragged her anchor about 2 o'clock in the morning until the anchor caught in the pipe line in the bottom of the channel in 30 feet of water. Where the anchor hit the pipe it bent the pipe to a 90-degree angle, broke a piece out of the top of the pipe at the bend and pulled the ends apart at the break until there was an opening of 100 feet between them.

The point of the break was nearly 3,000 feet from the Portland shore and this section of pipe was pulled off shore 9 feet, leaving an open space of this length where the galvanized and cast iron pipe joined. We filled this 9-foot space with a piece of cast iron pipe, and then attached an air compressor to the Portland end of the line. This machine was of a capacity to furnish 23 cubic feet of free air per minute. It required about two hours for the air to drive the water out of the open end of the pipe at the break. Then the air appeared at the surface, causing the water to appear to boil over an area 10 feet in diameter.

A diver was sent down to attach a line to the end of the pipe from which the air came, and find the other end. He found the pipe buried about 2½ feet in the soft mud, but was able to dig out a hole and get a line tied to the pipe. He could not find the other end of the break and it was necessary to carry the air compressor to Little

Diamond island and connect it to that end of the line. This was effective and showed the two ends to be 100 feet apart.

A line was then attached to this end of the pipe and an attempt was made to raise both ends to the surface and connect them together with three Moran joints in the line and then lower them to the bottom. They could be raised to the surface, but when lowered again invariably broke off 3 or 4 lengths back from the end.

Thus at every attempt the opening between the two ends became greater. We attached lines to the pipe 100 feet apart and tried working them up together but with no better success.

We determined that the suction of the mud on the pipe was very great and held the pipe with such force that it would break off or pull out at the first coupling out of the mud. Furthermore, the wind blew almost continuously at a rate that tossed the scows around and added to the strain on the pipe. The weather would not allow two successive days' work and the expense of the crew and boats was about $250 daily.

After working from November 3 to December 10, and spending $5,700, it was decided to wait until the winter weather was past before making any further attempts to repair the line.

It was shown, by examination of the pipe that broke off in attempting to raise it, that the pipe would bend a little before the joint would fail and it seemed that if the joint was a little stronger it would be possible to raise and lower the pipe as often as desired.

We accordingly designed and tested a method of strengthening the joints. We cut off a piece of 8-inch galvanized wrought iron pipe, 13 inches long. This was placed over the coupling between the two pieces of 6-inch wrought iron pipe and held in place by small wooden wedges. The space between the 6-inch pipe and coupling and the 8-inch sleeve was then filled with Leadite. The Leadite cooled in two or three minutes so that the collars and clay could be removed.

We then suspended the section of pipe at its two ends and piled pigs of lead on a platform suspended at the center by a rope on each side of the joint. It required 3,800 pounds of lead to exceed the elastic limit of the pipe metal and put a permanent bend in the pipe.

We then tried a joint, using Metallium for filling, and tested it by putting one end of the pipe under a building and raising the other end.

In both cases the pipe bent but the sleeve held the coupling without any sign of movement nor was there any sign of crushing either the Leadite or Metallium.

On April 12 of this year the wind moderated and we again took up the work where we left it in December. We completed the work in two weeks at a cost of $3,600, in the following manner:

We used two flat-bottomed scows, 20 x 40 feet, each equipped with gasoline winches, a tug boat and a crew of ten men.

The air compressor was attached to the Portland end of the pipe to force the water out and keep it out in order that it might be lighter to raise.

We used no diver, but dragged an anchor along the bottom until it caught the pipe. Then the pipe was raised a few feet from the bottom with the anchor, and a line was swept under it and a slip knot tied and carried to the hoist. The pipe was then raised about ten feet more and another line swept under the pipe as far as possible toward where it emerged from the mud. The second scow then lifted a few feet on this line to loosen the suction of the mud, and another line swept still further back. This operation was repeated until the end of the pipe was up on the scow. The laying of pipe was immediately begun, each coupling being covered with an 8-inch sleeve and the space filled with Leadite.

The tide was low and little wind blowing, and beginning at the middle of the deep channel and moving toward Little Diamond island, we laid 200 feet of pipe and lowered it to the bottom before dark with a plug screwed into the end. The following day at low tide we raised the end from the bottom easily, as all the joints were then reinforced, and continued laying pipe.

This work was continued until the pipe was laid up to where the water was about 12 feet deep at low tide. The Little Diamond island end of the pipe was then raised and 100 feet of pipe removed, leaving the two ends five lengths of pipe apart. The two scows were then swung around end to end ranging along the line of the pipe with the pipe hanging at their sides. The five lengths of pipe necessary to complete the line were then placed in position with four Moran joints inserted to provide flexibility.

The next move was the lowering of the pipe and at the same time pulling it to one side, forming a slight curve in the line.

The air compressor showed the line to be tight, and the same day we began supplying water to Peaks island.

The work was carried on under the immediate supervision of Harry U. Fuller, of the Portland Water District.

June Building Operations

According to the F. W. Dodge Co.'s review of construction activities during June in 27 northern states, the contracts awarded amounted to $227,711,000, which was 6 per cent less than in May. Of this amount 33 per cent was for residential buildings, 22 per cent for public works and utilities, 7 per cent for business buildings, 10 per cent for educational building and 28 per cent for industrial buildings. The increased activity was notable in places where there was most labor trouble.

The total amount of contracts awarded from January 1 to June 1 amounted to $1,066,256,000, which is 9½ per cent greater than the average semi-annular total for at least five years. The largest amount of business was in New York state and the northern New Jersey district, which totaled $62,659,000; an increase of 8 per cent over May; the central west almost equaling it with $61,028,000, a decrease of 16 per cent from May.

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The excavation of the entire cross section practically at a single face; a reduction of drilling by the use of channeling machines in the headings; the uninterrupted handling of the muck by a steam shovel constantly served by trains of empty and full cars on a double track service line to avoid loss of time; the delivery of concrete to the steel forms by a combination of dump car and pneumatic distribution; the installation of abundant high-class mechanical power equipment, and the development of a high degree of emulation and efficiency by rivalry among the workmen in the adjacent twin tunnels, are all important construction features which have made possible the establishment of a new high record of 620 cubic yards of muck excavated daily and 20 feet advance from two rock headings maintained for an uninterrupted period of more than three months. Such results need no comment and are themselves a high encomium of the zeal, ability, and co-operation of the engineers and contractors and for the selection and abundance of equipment installed.

Set-Back Lines for Highways

Highway traffic has, during the past few years, increased in both intensity and character until it now approaches, in each of these respects, the condition of city traffic a few years ago. With this development, the paving of highways is approximating more and more to that of city streets. Counties are using as paving material brick, sheet asphalt and even stone block, asphalt block and wood block.

In the matter of width, however, most of the highway pavements remain narrower than those found in city streets. With the relatively small amount of stopping along the side of the highway, it probably will not for years be necessary to provide a section of the pavement width for standing vehicles, since these can be drawn up along the shoulders, or on special paved areas where necessary. It is, however, becoming apparent that many of our highways are altogether too narrow for the moving traffic and must be widened, and foresighted engineers and other highway officials will make provision for this both in designing the cross-section and in the total width of the road right of way.

Definite action along this line has recently been taken in Pennsylvania, as told elsewhere in this issue, the legislature of that state having authorized the State Highway Commission to secure a width of 120 feet for its main highways wherever it seems that traffic in the future may make such width desirable. Except where the highways are passing through cities, the provision of the additional width necessary by securing strips of farm lands on one or both sides should not be very expensive; but should the matter be delayed until houses, barns and other buildings should be built along the present boundary line, the cost of widening might be greatly increased.

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The principle is similar to that involved in the provision for set-back lines in city streets. It does not seem desirable to take over immediately the entire width, which in many cases is at least double that which can be used to advantage at present; in fact, it would probably be cheaper and secure better results should the farmers be allowed to occupy the surplus width as farm land until it is needed. It is the part of wisdom, however, to make some arrangement at once while it can be done at little expense, for securing the right to use this additional width whenever it may be found necessary.

Decision as to Paving Materials

According to a local paper, a new policy has been adopted for Newark, N. J., by the director of the Department of Streets and Public Improvements, this being that the selection of materials to be used in laying new pavements shall hereafter be made by the engineers of that department and not by the abutting property owners. It is stated that a law which has now ceased to be in force practically made it mandatory for the city to lay any material that might be petitioned for by owners of more than half of the abutting property on any block.

Several years back a great many cities followed this practice either through legal compulsion or for other reasons, but fortunately practically all have abandoned it. As the editor of the paper in question remarks: "The city engineers are best qualified to exercise such judgment."

Steel Bridge Burns Down

Fear of the destruction by fire of old wooden bridges is generally entertained by those responsible for them, but in the case of steel bridges, fire has not been so much feared. However, on July 8, a steel bridge at Pittsburgh was burned and two of the three spans completely destroyed. The combustible matter in this case was the creosoted wood block floor, the heat from which was so intense as to warp the steel trusses out of shape and cause them to drop into the river.

The bridge so destroyed was that known as the Thirteenth Street bridge across the Alleghany river from Pittsburgh to Alleghany. The falling trusses completely blocked traffic in the river. The bridge was an old one and the county engineers had recently been ordered by the government to rebuild it in connection with the building of the Lake Erie canal. The cause of the fire is not known but it was conjectured that it might have been caused by crossed electric wires, by sparks from a steamer passing beneath, or by a leak in the 12-inch gas main which was carried by the bridge.

Three years ago the Sixteenth Street bridge across the same river was destroyed by a spectacular fire.

The Hackensack River Pollution

That the Hackensack river is rapidly approaching the condition of the Passaic, owing to pollution by Hackensack, Jersey City and other communities, is a statement made by the State Board of Health of New Jersey in connection with its announcement made on July 9 that Hackensack must at once make preparations for treating the sewage which it now discharges into that river. Both Hackensack and Jersey City were ordered a number of years ago to stop emptying raw sewage into the Hackensack river, but during the world war the matter was dropped. Now, however, the State Board of Health has made renewed demands upon these cities and has notified them that no further extensions of the sewer systems will be permitted until provision is made for purirying the sewage.

Pennsylvania Anticipating Wider Highways

At the instance of the Pennsylvania State Highway Department the 1921 legislature has enacted legislation which will give the State Highway Department power to increase the width of important thoroughfares where they deem it necessary. The department for two years has been studying traffic conditions on thoroughfares leading to important municipalities of Pennsylvania and expects eventually to increase the width of many of these, although little if any actual work of this kind will be done immediately. Width will be established, however, in much the same way that municipalities establish building lines along undeveloped streets.

The department hopes by this procedure to save the enormous expenditure which will necessarily be entailed in widening arterial roadways after improvements have been completed. The department is looking ahead fifteen or twenty years and expects ultimately to widen a number of the arterial thoroughfares to the 120 feet of width which the legislature has authorized.

It is anticipated that eventually it will be necessary to build thoroughfares skirting the larger municipalities and wide enough to accommodate several streams of traffic going in each direction. "Within a few years it will be unwise to send heavy trans-Pennsylvania traffic into Philadelphia and Pittsburgh, for example, inasmuch as addition of this traffic will add to the congestion of the downtown districts. Consequently wide roads must be provided around the larger cities so that traffic may be accommodated."

F. B. Crocker

Professor F. B. Crocker, electrical engineer, founder and head of the School of Eletcrical Engineering at Columbia University, died at his home in New York July 9. Professor Crocker was one of the pioneers of the electrical industry, to which his most conspicuous contribution was the commercial motor, first put into use in 1886. He was one of the founders of the C. & C. Company, and of the Crocker-Wheeler Company. He was interested in the standardization of electrical equipment throughout the world and in this interest was one of the two American delegates to the International Electro-Technical Commission in London. During the war he was advisor to the members of the Naval Consulting Board.

$252,000,000 Great Lakes-St. Lawrence Ship Canal Recommended

Colonel W. P. Wooten, United States Army engineer, and W. A. Bowden, chief engineer for Canada, have submitted to the International Joint Commission at Washington their report recommending the construction of a 142-mile ship canal between the Great Lakes and the lower St. Lawrence river at an estimated cost of $252,728,200.

It will have a depth of 25 feet, with provision for increasing it to 30 feet, at an additional cost of $17,986,180. There will be nine locks, 33 miles of canals, 40½ miles of lake channel and 108 miles of river channel. Maintenance would cost $2,562,000 a year, the engineers estimate.

Provision is made for a power plant with 1,464,000 horsepower through a great dam at Long Sault Rapids, near Ogdensburg, N. Y., which would develop about 40 per cent of the potential power in the St. Lawrence river.

Road Construction Plant*

By B. H. Piepmeier†

Several small plants preferable to one large one. Transportation of aggregate and concrete. Use of pneumatic-tired trucks. Railroad equipment.

Successful road work offers more possibilities for different types of plants than perhaps any other single line of building construction, and every section of road to be built is a field for intensive study and investigation by the engineer and contractor.

A successful road contractor in Illinois states: "No equipment should be purchased by a contractor unless he has sufficient work in view to enable him to practically pay for the equipment with a reasonable profit." Such a statement should in no way discourage the road contractor in equipping himself thoroughly to do economical road work, but should force him to make a more complete analysis of his job before he invests in a road-building plant.

SMALL DUPLICATE CONSTRUCTION UNITS ADVANTAGEOUS

In general, the building of a system of roads requires the installation of a number of small plants in preference to a few large plants. This has been particularly true in the past on account of (1) the contractor's inability to secure experienced and capable superintendents for handling large-plant operations; (2) railroad transportation falling short in the delivery of sufficient materials to keep large plants working efficiently; and (3) frequent breaking of the machinery required in large road-construction plants.

The small construction unit necessitates doing many operations by hand at somewhat greater expense than if done with machinery; however, when the final analysis is made, the small unit will show considerable efficiency on account of the possibility of its operating many times independently of any one particular machine out of service through breakdown.

Conditions existing during the past few years have made it impossible for the contractor with a large plant layout to show a fair profit. As soon as labor and transportation conditions become more stabilized, the large plant will show a much greater efficiency.

Contractors must give considerably more thought to the design of road plant so that its successful operation may not be wholly dependent upon one piece of machinery. Many successful road contractors realize already that to insure a constant and uniform output, it is economy in many instances to duplicate machines.

In many instances duplicating concrete mixers has prevented a complete shutdown of operations. The average road job may not always justify a duplication of the mechanical units, but where a large season's work is required, a serious investigation of the advantage of the duplicate units should be made.

TRANSPORTATION OF MATERIALS

The transportation problem in road building is one of the most important factors in the economical construction of roads. Consequently this part of the plant operation should be given a great deal of study. The transportation cost should not only be estimated on the basis of the ton-mile cost but the effect it may have on the cost of operation of the remainder of the construction plant should be taken into consideration. Hauling cost varies from 20 to 40 cents per ton-mile. In a season's work a saving, therefore, of but a few cents per ton-mile may amount to several thousand dollars. The actual hauling costs may be exceedingly low, yet if the delivery affects the maximum output of the remainder of the plant, the inefficiency should naturally be charged against transportation cost.

Inasmuch as most specifications now prohibit storing road materials upon the subgrade, the road contractor is compelled to provide for transportation in one of two ways. He must deliver materials from his material yard to the road by industrial railroad equipment or by truck. The industrial equipment, while expensive in first cost, will enable the contractor to complete his work with a minimum amount of trouble under normal conditions and regardless of weather, the average industrial equipment will insure a more uniform delivery of materials than any other unit that may be used. The chief objection to the industrial unit is that it is limited to road construction with grades ordinarily less than 4 per cent and a minimum number of railroad crossings. Further objection would be that the high initial cost demands a large mileage of roads be built each year in order to absorb the interest on the investment and the depreciation.

In recent years truck delivery has superseded team delivery, being more rapid and delivering material to a paving mixer or from a mixer direct to the road with less disturbance to the roadbed. Truck transportation of road materials is very

*Excerpt of paper presented at the spring meeting of the American Society of Mechanical Engineers.

†Engineer of Construction, State of Illinois, Division of Highways.

flexible and therefore suited to more different sections of work than perhaps any other method of transportation. It is especially suited to the delivery of mixed concrete from a central plant to the road being improved, and to the delivery of proportioned batches direct to the paving mixer or to a point at which the batch boxes may be transferred to a short industrial line which in turn delivers them to the paving mixer.

DELIVERY OF CONCRETE FROM CENTRAL MIXING PLANT

The delivery of mixed concrete from a central mixing plant direct to the job enables the contractor to centralize operations and in many instances to economize in plant and operating expenses. It would seem possible that unloading aggregate and cement from railroad cars, mixing the materials to the desired proportions and consistency and turning out a mixed concrete, could be standardized to such an extent that central plants could be simplified and made more economical in operation. It is hoped that the mechanical engineer and the equipment designer will assist in the design of a practical and economical central mixing plant unit.

Mixed concrete may be delivered by industrial equipment, provided the hauls are reasonably short and the equipment is designed for small loads with considerable speed in transportation. The small pneumatic-tired truck will usually prove the most efficient machine for delivery of mixed concrete, taking the individual batch of mixed concrete direct from the mixer to the road being improved in the least possible time.

USE OF THE PNEUMATIC-TIRED TRUCK

The pneumatic-tired truck is essential when speed is an important factor in delivery and where it is necessary to do considerable hauling over the subgrade. This truck will usually reduce the load on the subgrade to less than 125 lbs. per square inch of surface, and this pressure, even though frequently applied, does not seriously injure or displace a prepared subgrade having average conditions.

It is true that it is practically impossible to deliver materials over earth roads with trucks when the roads are muddy or during rainy periods. However, the road may be materially improved and the truck used practically the entire construction season if the road is constantly maintained by the use of the road drag and given an application of half a gallon of oil per square yard of surface early in the construction season.

The light pneumatic-tired truck may also be used for the delivery of proportioned batches of aggregates direct to the paving mixer on the road being improved. There are now on the market many types of batch boxes and dump bodies which permit the batches to be dumped directly into the skip of the paving mixer. This method has proved to be very satisfactory. It differs from the delivery of mixed concrete in that a paving mixer is used instead of the stationary building mixer, and most of the operations of the contractor are out where the road is actually being laid.

IMPROVEMENTS IN DESIGN OF EQUIPMENT DESIRABLE

The plant investment of the road contractor of to-day is entirely too expensive compared with the work accomplished during a single construction season or from one particular installation of a construction plant. From $60,000 to $100,000 worth of plant equipment is frequently set up to build less than ten miles of highway. This is equivalent to charging off $2500 to $3,000 for equipment against every mile of road built. It is doubtful whether there is any other building construction in which so much depreciation and interest on plant investment must be charged off on so small an amount of work.

Many of our road-building machines are being made larger, more cumbersome, and more expensive each year. The fact that road-building machinery is subjected to more severe use than perhaps any other machinery used in building construction has induced the manufacturer to add to his equipment each year to insure more rigid construction. Many machines, such as the concrete paving mixer, can undoubtedly be completely redesigned and a machine produced much smaller in size, to mix more concrete and be less cumbersome on the job.

If the mixer designer can produce a smaller machine having a greater output per hour of operation and so designed that the consistency of the concrete produced can be controlled by the operator instead of by some unsatisfactory mechanical means, the results will be a wonderful aid to the road-building industry.

IMPROVEMENT IN RAILROAD EQUIPMENT

Practically all road contractors now unload aggregates from open-top cars by means of clam shells. This method is not always the most economical, but the contractor is forced to use it as he cannot secure all hopper-bottom cars he might desire. On account of the large volume of road materials to be delivered by railroad cars, some type of car should be designed that would permit of more rapid unloading by more economical methods. If this is not done, it is hoped at least that open-top-car manufacturers will improve the design of their cars and make them so that they can be more easily unloaded with clam-shell equipment.

Many open-top cars are now designed with projecting angles, rivets, bolts, braces, timbers, etc., which interfere with the efficient operation of the clam shell. It is difficult to understand why railroad cars could not be designed so that the interior of the car would be perfectly smooth. In fact, it would be practicable and economical for all open-top cars to be built with a fillet having a radius of about 18 inches in the bottom angle at the ends of the car. The curved bottom angles would permit the cars to be emptied more rapidly and economically either with hand shovels or clam shells.

Further investigation should also be made of the use of open-top removable batch boxes for railroad transportation of materials. While the substitution of standardized batch boxes for open-top cars would be a very radical departure from present equipment, the average construction plant could be designed to handle the boxes much more economically than the loose materials.

Mechanical Equipment of Baltimore Water Department*

By V. Bernard Siems†

Comparison of itemized costs of excavating for and laying 6-inch to 36-inch mains by hand and by aid of machinery. Includes depreciation charges on all equipment, overhead charges, costs per foot of pipe and of service, etc.

During the winter months trenching machines, cranes, backfillers, air compressors, etc., are removed to the storage yards and completely overhauled. This is done only when there is no work on which this machinery can be used. The smaller gasoline pumps, melting furnaces, ground thawers, etc., are usually overhauled in the field.

COMPARISON OF COSTS—HAND LABOR VS. HAND LABOR AIDED BY MACHINERY

Curve No. 1 of Fig. 2‡ shows the comparison of labor cost per foot of installation of water mains by manual labor and manual labor aided by trenching machine. Referring to the table accompanying this curve, it will be seen that the percentage of economy obtained using a trenching machine with hand labor varies from 22.2 to 57.4 per cent. This percentage of saving is largely due to the intelligent placing of the laborers. For example: With an average corps of 14 men working with a trenching machine in the installation of a 6-inch water main, two laborers work on the surface to remove the material falling from the traveling buckets, three laborers are used to prepare the trench for pipe laying, two caulkers and two laborers pour the lead and caulk the joints, four laborers backfill the trench and ram the material, and one laborer attends to the lead melting furnace and keeps the water main installation corps supplied with tools. Such an organization will permit constant operation of a trenching machine throughout the working day.

The labor costs shown on Curve No. 1 are average ones which include excavating and backfilling of trench, installation of the cast iron pipe and the overhead of the watchman and foreman. The standard dimensions of trench use by the Department are shown below Curve No. 1. From experience we have found that four feet of cover will prevent freezing and the pipe will not be affected by vibration caused by heavy motor vehicles.

Curve No. 2 of Fig. 2 shows the comparison of excavation cost per foot of installation of water main by manual labor and trenching machine aided by manual labor. The percentage of saving with the use of the trenching machine varies from 50 to 56.8 per cent. A trenching machine will excavate from 15 cubic yards an hour in 50 per cent rock and sandstone to 25 cubic yards an hour in loam, gravel and disintegrated rock.

Curve No. 3 of Fig. 3 shows the comparison of average number of feet of water main installed by a man a day by hand labor and by hand labor aided by trenching machine. The term "installed" includes the excavation for, installation and backfill of the water main. This curve shows the saving of time in the installation of water mains by the use of the trenching machine. Referring to the table above the curve you will see that the percentage of time saved varies from 33.3 to 80.0 per cent. For example, it will take a water pipe corps of fifteen men installing water mains without the use of a trenching machine ten days to excavate for, lay and backfill 300 feet of 20-inch main; whereas a pipe laying corps using a trench-

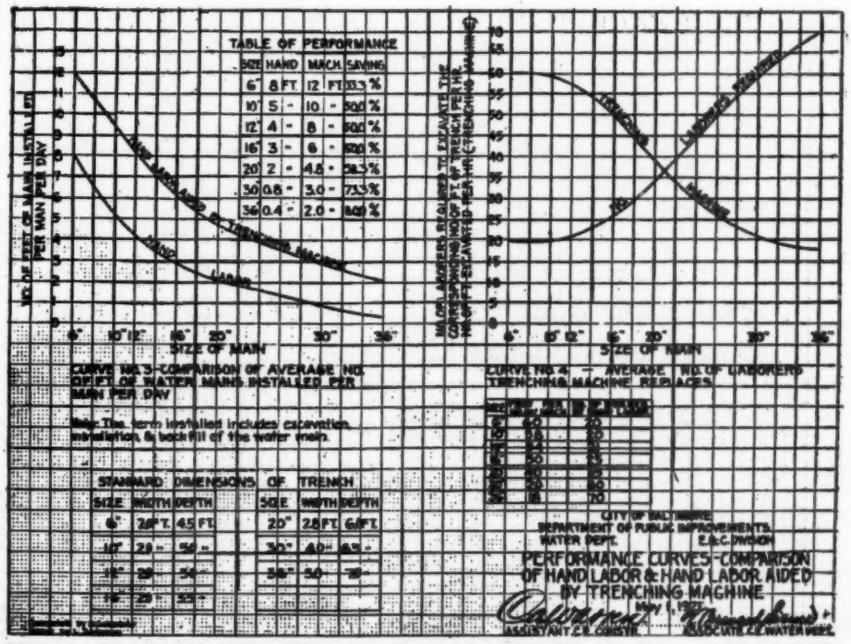


TABLE OF PERFORMANCE
SIZE HAND MACH. SAVING
6" 8 FT 12 FT 33.3 %
10" 5 - 10 - 50 %
12" 4 - 8 - 50 %
16" 3 - 6 - 50 %
20" 2 - 4.5 - 55.5 %
30" 0.8 - 3.0 - 73.3 %
36" 0.4 - 2.0 - 80 %
SIZE OF MAIN
CURVE NO. 3-COMPARISON OF AVERAGE NO. OF FT. OF WATER MAINS INSTALLED PER MAN PER DAY
STANDARD DIMENSIONS OF TRENCH
SIZE WIDTH DEPTH
6" 28" 4.5 FT.
20" 28" 6 FT.
30" 40" 8 FT.
CURVE NO. 4 — AVERAGE NO. OF LABORERS TRENCHING MACHINE REPLACES
CITY OF BALTIMORE
DEPARTMENT OF PUBLIC IMPROVEMENTS
WATER DEPT.
E.&C. DIVISION
PERFORMANCE CURVES-COMPARISON OF HAND LABOR & HAND LABOR AIDED BY TRENCHING MACHINE
May 1, 1921

FIG. 3—PERFORMANCE CURVES—HAND LABOR VS. HAND LABOR AIDED BY TRENCHING MACHINE

*Continued from page 42. Paper before American Water Works Association.

†Associate Civil Engineer, Baltimore Water Department.

‡For Fig. 2, see p. 40 of last week's issue.

ing machine to excavate the trench will complete the excavation, laying and backfilling of the 20-inch main in four days and two hours. Below this curve is a table of the standard dimensions of trench.

Curve No. 4 of Fig. 3 shows the average number of men the trenching machine replaces. This curve depicts the trenching machine as a labor-saving device. Upon examining the curve and the table, you will find that the number of men replaced by the use of the trenching machine varies from 20 to 70 men. For an example, take a 6-inch main: The number of linear feet of trench excavated in one hour by the trenching machine is 60, but it would require 20 men to excavate the 60 feet of trench in one hour. The same principle applies to the other size mains, the table giving the number of men replaced by the trenching machine for water mains of every size. This curve and table were prepared from the average of a number of installations of water mains of each size noted upon the diagram.

Curve No. 5 of Fig. 4 shows comparison of labor costs per foot of water mains between joints caulked by hand and those caulked with the use of pneumatic tools. The term "laying" refers only to the placing of the pipe in the trench and to the caulking of the joints. In the table of comparison of cost of caulking by hand and caulking with air hammers, you will notice that there is a loss varying from 37 to 53 per cent in favor of hand caulking, but this loss is overcome by the saving in time varying from 41.7 to 65.7 per cent by caulking with air hammers, thus resulting in a saving of 36.4 to 46.7 per cent on the completed work.

Curve No. 6 of Fig. 4 shows the comparison of backfill costs per foot of installation of water mains by hand labor and by backfiller. Noting the curve and tables, you will find that the percentage of saving varies from 33.3 to 52.5 per cent. Below the curve is a table of the standard dimensions of trench.

In order to determine the effective depth to which lead could be compressed in the caulking of cast iron water pipe joints, research work was initiated at the Municipal Laboratory in 1914. The results of these tests showed that lead, like other engineering materials, has a distinct characteristic curve. From this curve can be found the greatest possible compression, which never exceeds 2½ inches from the face of the bell, before the compressive molecular resistance of the lead itself equals or is greater than the tensile strength of the cast iron in the sides of the pipe bells. When such latter is the case, there immediately follows a bursting of the pipe bell; therefore, it was recommended that air compressors and pneumatic hammers operating under a long stroke and a moderate working pressure of 40 pounds per square inch be used on all the Department's caulking work.

A comparison of cost of the laying of water mains by hand labor and hand labor aided by crane on pipe 30 inches and larger shows that it cost $.54 a foot to lay 30-inch pipe with hand labor aided by crane, and $.95 a foot to lay by hand labor alone, or a saving of 43.1 per cent by using the crane. On 36-inch pipe it cost $.70 a foot to lay with hand labor aided by crane, and $1.42 to lay with hand labor alone, or a saving of 50.7 per cent.

Table No. 1 shows the method of ascertaining the cost per hour of operating machinery. The explanation is given in the notes at bottom of the table.

Table No. 2 shows cost per foot of installation of water mains during part of years 1920 and 1921 by hand labor and by hand labor aided by trenching machine. The labor costs per foot (Column No. 2) shown in this table, include the cost of inserting small connections, such as 6-inch, 10-inch or 12-inch, and the installation of 6-inch, 10-inch and 12-inch valves at an average distance of 400 feet, which constitutes the length of a city block. The same applies to the material cost per foot of installation of 6-inch, 10-inch and 12-inch water mains (Column No. 4). The columns are explained by the notes at the bottom of the table.

Table No. 3 shows the hourly rate of pay and water works material cost. An explanation is given in the notes at bottom of the table.

Table No. 4 shows methods of ascertaining depreciation charges on standard tools and equipment of water pipe construction foremen. These computations are the result of investigation of

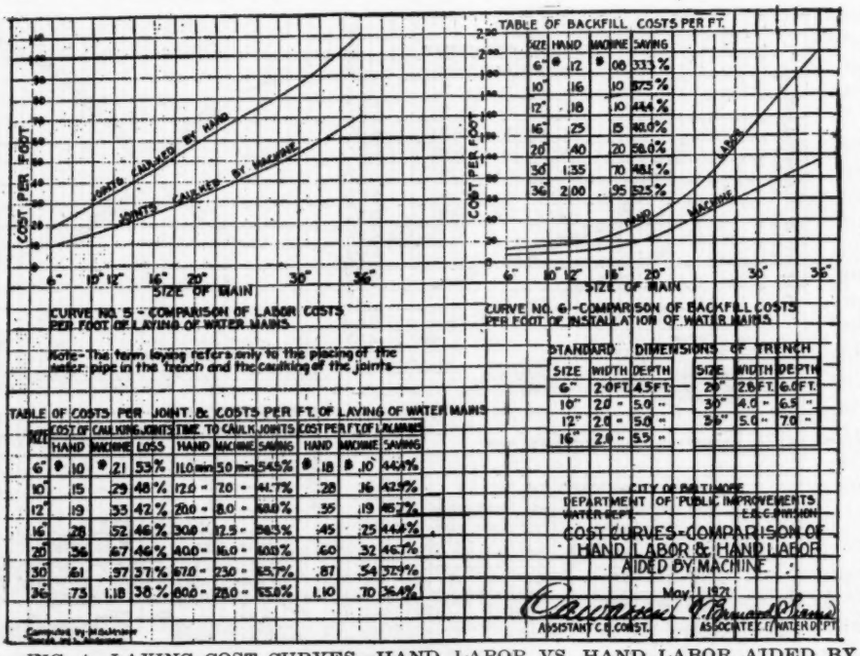

COST PER FOOT
SIZE OF MAIN
JOINTS CAULKED BY HAND
JOINTS CAULKED BY MACHINE
CURVE NO. 5 - COMPARISON OF LABOR COSTS PER FOOT OF LAYING OF WATER MAINS
Note - The term laying refers only to the placing of the water pipe in the trench and the caulking of the joints
TABLE OF COSTS PER JOINT & COSTS PER FT. OF LAYING OF WATER MAINS
TABLE OF BACKFILL COSTS PER FT.
CURVE NO. 6 - COMPARISON OF BACKFILL COSTS PER FOOT OF INSTALLATION OF WATER MAINS
LABOR
HAND
MACHINE
STANDARD DIMENSIONS OF TRENCH
CITY OF BALTIMORE
DEPARTMENT OF PUBLIC IMPROVEMENTS
WATER DEPT.
COST CURVES - COMPARISON OF HAND LABOR & HAND LABOR AIDED BY MACHINE
May 1, 1921
ASSISTANT C.E. CONST.
ASSOCIATE ENGR. OF WATER DEPT.

FIG. 4—LAYING COST CURVES—HAND LABOR VS. HAND LABOR AIDED BY MACHINE

field conditions and are not assumptions. The depreciation charges are based upon a year of 300 working days.

Table No. 5 shows the methods of ascertaining the percentage of labor cost per foot of water main installations, covering loss and depreciation of tools. These results are explained by the notes.

Table No. 6 shows the method of ascertaining the overhead charge against each construction order. The Water Department consists primarily of the Engineering and Construction Division, Mechanical Division and Filtration Division. The Executive and Auditing Divisions are not considered separate as their entire operating cost is divided among the three above-mentioned divisions. The Construction Subdivision being one of three subdivisions of the Engineering and Construction Division, 11.11 per cent of the salaries of the Executive and Auditing Divisions of the Water Department, 33.33 per cent of the salaries of the executive and clerical forces of the Engineering and Construction Division, 100 per cent of the salaries of the engineers and clerks of the Construction Subdivision, the expenditure of the Bureau of Drafting for preparing Water Department plans and 11.11 per cent of the miscellaneous appropriations (buildings, equipment, automobiles, instruments, stationery, etc.) are charged to the Construction Subdivision as overhead. Dividing the total sum obtained as overhead by the total estimated expenditure of the Construction Subdivision, the percentage of overhead is obtained.

Tables Nos. 7 to 10 show the cost per foot of installation of water supply services, valves and fire hydrants, also standard dimensions of valve vaults. The costs per foot of installation of water supply services include tapping the main, insertion of the corporation, lead tail, lead lined

Table No. 2

Cost Per Foot of Installation of Water Mains Part of Years 1920 and 1921 by Hand Labor and Hand Labor Aided by Machinery

	Hand Labor						Hand Labor Aided by Machinery						
Size (1)	Labor cost per foot (2)	Miscellaneous cost per ft. (3)	Material cost per ft. (4)	Depreciation cost per ft. (5)	Overhead cost per ft. (6)	Total cost per foot (7)	Labor cost per foot (2)	Miscellaneous cost per ft. (3)	Material cost per ft. (4)	Depreciation cost per ft. (5)	Overhead cost per ft. (6)	Total cost per foot (7)	Condition of subsurface (8)
6 in.	$1.85	$0.10	$1.70	$0.19	$0.38	$4.22	$1.30	$0.10	$1.70	$0.13	$0.32	$3.55	Maximum
6 in.	0.90	0.10	1.70	0.09	0.28	3.07	0.70	0.10	1.70	0.07	0.26	2.83	Average
6 in.	0.55	0.10	1.70	0.06	0.24	2.65	0.40	0.10	1.70	0.04	0.22	2.46	Minimum
10 in.	2.60	0.13	2.60	0.26	0.56	6.15	1.80	0.13	2.60	0.18	0.47	5.18	Maximum
10 in.	1.30	0.13	2.60	0.13	0.42	4.58	0.90	0.13	2.60	0.09	0.37	4.09	Average
10 in.	0.90	0.13	2.60	0.09	0.37	4.09	0.55	0.13	2.60	0.06	0.33	3.67	Minimum
12 in.	2.85	0.15	3.25	0.29	0.65	7.19	2.10	0.15	3.25	0.21	0.57	6.28	Maximum
12 in.	1.90	0.15	3.25	0.19	0.55	6.04	1.00	0.15	3.25	0.10	0.45	4.95	Average
12 in.	1.10	0.15	3.25	0.11	0.46	5.07	.60	0.15	3.25	0.06	0.41	4.47	Minimum
16 in.	4.10	0.22	5.20	0.41	0.99	10.92	2.50	0.22	5.20	0.25	0.82	8.99	Maximum
16 in.	2.80	0.22	5.20	0.28	0.85	9.35	1.50	0.22	5.20	0.15	0.71	7.78	Average
16 in.	1.95	0.22	5.20	0.20	0.76	8.33	1.10	0.22	5.20	0.11	0.66	7.29	Minimum
20 in.	7.40	0.35	7.75	0.74	1.62	17.86	4.10	0.35	7.75	0.41	1.26	13.87	Maximum
20 in.	3.95	0.35	7.75	0.40	1.25	13.70	2.20	0.35	7.75	0.22	1.05	11.57	Average
20 in.	2.80	0.35	7.75	0.28	1.12	12.30	1.90	0.35	7.75	0.19	1.02	11.21	Minimum
30 in.	12.35	0.80	15.30	1.24	2.97	32.66	9.00	0.80	15.30	0.90	2.60	28.60	Maximum
30 in.	9.40	0.80	15.30	0.94	2.64	29.08	4.00	0.80	15.30	0.40	2.05	22.55	Average
30 in.	5.20	0.80	15.30	0.52	2.18	24.00	3.40	0.80	15.30	0.34	1.98	21.82	Minimum
36 in.	16.85	0.95	19.20	1.69	3.87	42.56	12.20	0.95	19.20	1.22	3.36	36.93	Maximum
36 in.	12.00	0.95	19.20	1.20	3.34	36.69	5.80	0.95	19.20	0.58	2.65	29.18	Average
36 in.	9.85	0.95	19.20	0.99	3.10	34.09	5.10	0.95	19.20	0.51	2.58	28.34	Minimum

Columns: No. 1—Water mains and fittings. No. 2—Excavating, laying, backfilling; overhead of foremen and watchmen. No. 3—Hauling pipe, fittings, etc., investigating subsurface obstructions; operating valves. No. 4—Cost of cast iron pipe, fittings, rope, timbers, etc. No. 5—10 per cent of labor cost (see table No. 5). No. 6—10 per cent of summary of columns 2, 3, 4 and 5. No. 7—Total cost of installation. No. 8—Material excavated and subsurface obstructions encountered. MAXIMUM (a) Material excavated—50 per cent sandstone, granite or other rock, or (b) subsurface obstructions of such a nature that (a) would apply as to time and cost of work (industrial sections). AVERAGE—(a) Material excavated—loam, clay, gravel and deteriorated rock, or (b) subsurface obstructions of such a nature that (a) would apply as to time and cost of work (industrial and business sections). MINIMUM—(a) Material excavated—sand, loam and gravel, or (b) subsurface obstructions of such a nature as found in typical residential public highways.

Table No. 3

Title	Hourly Rate of Pay Max.	Aver.	Min.
Water pipe Constr. Foreman	0.72	0.63	0.56
Labor foreman	0.54	0.54	0.54
Handy man	0.55	0.525	0.50
Pipe caulker	0.50	0.50	0.50
Special laborer	0.45	0.425	0.40
Night watchman	0.38	0.38	0.38

Material	Unit price	Material	Unit price	Material	Unit Price
Class B c. i. pipe	$71.00 per ton	¾-in. wrought iron lead lined pipe	$0.22 per ft.	¾-in. lead tail	$2.46
Cast iron fittings	$140.00 per ton	1-in. "	$0.30 per ft.	1-in. lead tail	$3.30
Coal	$0.115 per gal.	2-in. "	$0.70 per. ft.	2-in. lead tail	$12.49
oil					
Gasoline	$0.235 per gal.	¾-in. corporat'n	$1.34	¾-in. curb stops	$1.18
Lead	$0.55 per lb.	1-in. "	$1.45	1-in. curb stops	$1.80
Lumber	$0.045 board ft.	2-in. "	$7.04	2-in. curb stops	$7.34
Packing rope	$0.09 per lb.	3 ft. curb stop box	$1.50	5 ft. curb stop box	$1.95

Note: $71.00 per ton for class "B" cast iron pipe refers to unit purchase price in year 1920. Present unit price for class "B" cast iron pipe is $61.00 per ton. Other unit prices refer to purchases made in 1921.

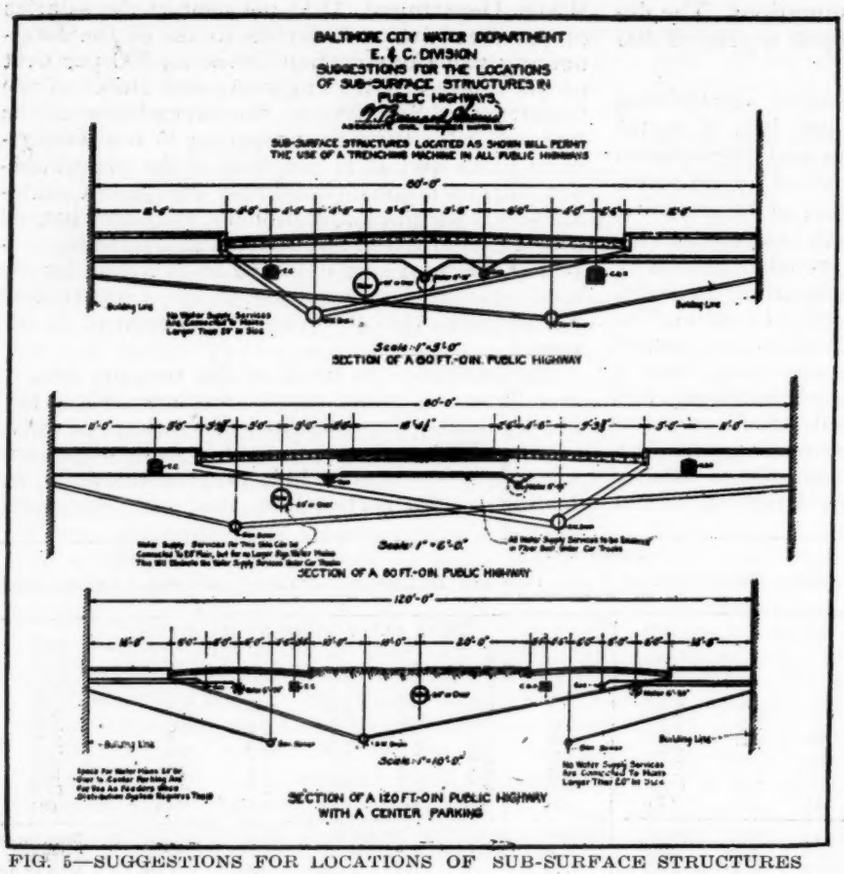

BALTIMORE CITY WATER DEPARTMENT
E. & C. DIVISION
SUGGESTIONS FOR THE LOCATIONS
OF SUB-SURFACE STRUCTURES IN
PUBLIC HIGHWAYS
SUB-SURFACE STRUCTURES LOCATED AS SHOWN WILL PERMIT
THE USE OF A TRENCHING MACHINE IN ALL PUBLIC HIGHWAYS
SECTION OF A 60 FT.-0 IN. PUBLIC HIGHWAY
SECTION OF A 80 FT.-0 IN. PUBLIC HIGHWAY
SECTION OF A 120 FT-0 IN PUBLIC HIGHWAY
WITH A CENTER PARKING

FIG. 5—SUGGESTIONS FOR LOCATIONS OF SUB-SURFACE STRUCTURES

pipe, curb stop and curb stop box. The installation of cast iron water supply services includes the insertion of the sleeve and three-way, cast iron pipe, valve and roadway box. The cost of installation of valves includes the cost of the valve, lead blocking, packing, rope, etc. The cost of erection of the vault for valve includes the labor, material, depreciation and overhead. The cost of the installation of fire hydrants includes the cost of the insertion of three-way and sleeve, cast iron pipe, valve and fire hydrant.

LOCATION OF SUBSURFACE STRUCTURES IN PUBLIC HIGHWAYS

Fig. No. 5 shows sections of public highways of various widths, suggesting locations of subsurface structures so as to permit the use of trenching machines in most all the public highways.

These sections also show the possibility of placing public utilities structures in a definite location so as to safeguard against interrup-

Table No. 4

Method of ascertaining depreciation charges on standard tools equipment of a water pipe construction foreman—Construction sub-division.

Description of a Water Pipe Const. Foreman's Equipment for an Average Size Corps of 14 Men	Probable life of Equipm't	Original cost of Equipm't	Depreciation Cost per day of Equipm't
1 Watchman's House	5 years	$255.00	$0.17
1 First-Aid Cab. (compl.)	3 months	15.00	0.20
1 Oil stove	1 year	6.00	0.02
2 Tool boxes	2 years	50.00	0.08
15 Picks	6 months	17.00	0.11
15 Long-handle shovels	6 months	39.75	0.26
4 Mattocks	6 months	8.00	0.05
2 Digging Bars	6 months	6.80	0.05
2 Steel bars	6 months	7.60	0.05
6 Wall points	3 months	12.00	0.16
10 Ditch jacks	1 year	50.00	0.17
4 Sledge hammers	3 months	8.00	0.10
4½ lb. hammers	3 months	5.00	0.07
1 Adz	6 months	2.00	0.01
1 Axe	6 months	2.00	0.01
4 Gallous keys	1 year	12.40	0.04
2 Socket keys	1 year	6.00	0.02
4 Hydrant keys	1 year	6.32	0.02
2 N. S. Hydrant keys	1 year	3.00	0.01
2 Corporation keys	1 year	4.50	0.02
2 Curb stop keys	1 year	2.00	0.01
12 Handle diamond point tools	3 months	12.10	0.16
6 Finger diamond point tools	3 months	9.00	0.12
5 Pipe cutters (handle)	3 months	6.25	0.08
6 Pipe cutters	3 months	10.50	0.14
5 Breaking-out chisels	3 months	7.50	0.10
3 Long chisels	3 months	4.80	0.07
10 Roping tools	9 months	11.00	0.05
3 Lead runners	6 months	45.00	0.30
1 Hauck lead melting furnace	2 years	88.35	0.15
3 9-in. ladles	1 year	9.00	0.03
1 6-in. ladle	1 year	2.00	0.01
12 handle caulking tools	3 months	12.00	0.16
3 sets finger caulk. tools	6 months	36.00	0.24
1¾ in. Mueller tapping machine	1 year	180.00	0.60
3 Saddles	1 year	9.00	0.03
1 Vise	1 year	5.50	0.02
2 3-wheel pipe cutters	9 months	24.00	0.12
1 Set stocks and dies	6 months	15.00	0.10
1 Ditch ratchet (comp.)	1 year	25.00	0.08
3 Monkey wrenches	1 year	8.00	0.03
4 Stillson wrenches	1 year	11.32	0.04
2 Rasps	6 months	2.50	0.02
1 Oiler	2 years	2.50	0.01
3 Rammers	2 years	7.00	0.01
1 Wood chisel	1 year	5.80	0.02
1 8-in. single block	6 months	3.40	0.02
1 8-in. double block	6 months	6.00	0.04
1 Hand saw	6 months	2.50	0.02
1 cross-cut saw	6 months	8.35	0.06
1 Chain	6 months	2.40	0.02
1 Street broom	1 year	1.00	0.01
3 Buckets	3 months	1.95	0.02
10 Pairs rubber boots	6 months	50.00	0.33
15 Slickers	1 year	75.00	0.25
15 Standards	1 year	30.15	0.10
1 50-ft. tape	6 months	3.00	0.02
10 Red flags	3 months	5.00	0.07
		Total	$5.29

From the life and original cost, the depreciation for each water pipe construction foreman's equipment is **$5.29 per day.**

Note—Method of ascertaining the percentage of labor cost to apply to installation of water mains to cover the depreciation and loss of tools is shown on Table 5.

Table No. 8

Cost of Installation of Valves in (66-ft. public highway)

Size	HAND LABOR Labor cost (1)	Material cost (2)	Depreciation cost (3)	Overhead Cost (4)	Cost of erection of vault	Total Cost (5)
6 in.	$5.30	$31.20	$0.53	$3.70		$40.73
10 in.	6.20	74.95	0.62	8.18		89.95
12 in.	6.70	92.80	0.67	10.02		110.19
16 in.	8.20	131.86	0.82	14.09	$126.59	281.56
20 in.	15.20	281.95	1.52	28.87	169.18	497.72
30 in.	32.10	462.14	3.21	49.75	233.08	780.28
36 in.	41.10	1430.10	4.11	147.53	317.68	1940.52

tion of service. Should municipalities adopt a standard of location for subsurface structures in public highways, especially in the newer sections of cities, it will have a tendency to decrease the construction and maintenance costs.

The large amount of work completed by the Water Department has been due to the fact that Wm. A. Megraw, water engineer, has encouraged the purchase of machinery for use in the construction of water mains, which procedure was inaugurated Walter E. Lee, former incumbent.

Due acknowledgment is given herewith to the work of C. A. Warren, assistant civil engineer in charge of the Construction Subdivision of the Engineering and Construction Division, and to his assistant, Maurice Goldstein, junior civil engineer, for the cost data furnished.

Table No. 6
Method of Ascertaining Overhead Charge Against Each Const. Order by the Construction Sub-division of E. & C. Division

Water dept. divisions & sub-divisions	Salaries of employees	P. C. of salaries charged against const. order	Salaries charged as overhead
Executive division water dept.	$16,100.00	11.11%	$1,788.88
Auditing division water dept.	16,800.00	11.11%	1,866.66
Executive subdiv., E. & C. div.	10,400.00	33.33%	3,466.66
Clerical subdiv. E. & C. div.	21,870.00	33.33%	7,290.00
Construction subdiv., E. & C. div.			
1 Asst. civil engr. construction	2,500.00	100.00%	2,500.00
2 Junior civil engineers	3,300.00	100.00%	3,300.00
3 Engineering aids	3,550.00	100.00%	3,550.00
1 Junior clerk (cost acct. work)	1,200.00	100.00%	1,200.00
1 Timekeeper	1,400.00	100.00%	1,400.00
E. & C. Division drafting at Bureau of Drafting	8,137.80	100.00%	8,137.80
Total Salaries Charged as overhead			$34,500.00
Water dept., miscel. approps. (bldgs., equipment, autos, instruments, stationery, etc.)	94,500.00	11.11%	$10,500.00
Grand Total of Salaries and Miscellaneous Appropriations Charged as Overhead			$45,000.00

Total expenditures of Construction Subdivision of E. & C. Division is estimated at $450,000 for year 1921.

Percentage of Overhead $= \frac{\$45,000}{\$450,000} = 10\%$

Table No. 5
Method of Ascertaining Per Cent Labor Cost Per Foot Water Mains Installed Covering Loss and Depreciation of Tools.

Size	No. of men in water pipe const. corps.	No. of ft. water main installed by corps per day	Deprec. cost of tools per ft. of water mains installed		Aver. cost per ft. of water mns. covering loss & breakage of tools	Labor cost per ft. of water mains installed	P. C. of labor cost per ft. of water mains installation applied to deprec. and loss of tools	
(1)	(2)	(3)	(4a)	(4b)	(5)	(6)	(7a)	(7b)
6 in.	14	75	$5.29 / 75	$0.07	$0.02	$0.90	$0.09 / $0.90	10%
10 in.	14	60	$5.29 / 60	$0.09	$0.03	$1.30	$0.12 / $1.30	9.2%
16 in.	14	30	$5.29 / 30	$0.18	$0.04	$2.80	$0.22 / $2.80	7.9%
20 in.	14	25	$5.29 / 25	$0.21	$0.05	$3.95	$0.26 / $3.95	6.7%
30 in.	14	10	$5.29 / 10	$0.53	$0.07	$9.40	$0.60 / $9.40	6.3%

Column 1—Size of cast iron pipe class "B" and necessary cast iron fittings for a typical public highway. Column 2—Average sized water pipe construction corps. Column 3—Average number of feet of water mains installed by a corps of size noted in Column 2. Column 4a—Fraction equals total depreciation of tools divided by number of feet of water mains installed per day. (See Table 4 for depreciation on eacn tool.) Column 4b—Quotient of column 4a equals depreciation cost of tools per foot of water mains installed. Column 5—Loss and breakage of petty tools such as chisels, small caulking tools, etc. Column 6—Labor cost per foot of water mains installed. "Installation" includes excavation, laying and backfilling. Column 7a—Fraction equals depreciation cost plus breakage and loss of petty tools divided by labor cost per foot (Column 4b plus 5 divided by 6). Column 7b—Percentage of total labor cost that covers the depreciation, loss and breakage of tools.

Table No. 7
Costs per foot of installation of water supply services in (66-foot public highway)

Size	HAND LABOR				
	Labor cost per foot	Material cost per foot	Depreciation per foot	Overhead cost per foot	Total cost per foot
	(1)	(2)	(3)	(4)	(5)
¾-in. wrought iron lead lined pipe	$0.27	$0.66	$0.03	$0.10	$1.06
1-in. wrought iron lead lined pipe	0.30	0.78	0.03	0.11	1.22
2-in. wrought iron lead lined pipe	0.40	2.19	0.04	0.26	2.89
3-in. Class B c. i. pipe	0.45	2.15	0.05	0.27	2.92
4-in. Class B c. i. pipe	0.50	2.57	0.05	0.31	3.43

Note: Column 1—Excavation, laying, backfilling: overhead of foremen and watchmen. Column 2—Cost of cast iron pipe, fittings, lead, rope, timber, etc. Column 3—10 per cent of the labor cost (tools and equipment, see Table No. 5). Column 4—10 per cent of the summary of Columns 1, 2 and 3. Column 5—Total cost of installation.

Table No. 9
Cost of Installation of the Hydrants in (66-ft. Public Highway)

Size	HAND LABOR				
	Labor Cost (1)	Material cost (2)	Depreciation Cost (3)	Overhead Cost (4)	Total cost (5)
6 in.	$47.65	$106.75	$4.77	$15.92	$175.09

Table No. 10
Standard Vaults for Valves

Size of Valves	Size of Vaults			Thickness of Brick walls	Thickness of Rein-forced Concrete slab	Diameter of Manhole frame
	Length Inside	Inside Width	Average Depth			
16 in.	4.5 ft.	4.5 ft.	5.9 ft.	9 in.	6 in.	24 in.
20 in.	8.0 ft.	4.5 ft.	6.0 ft.	9 in.	6 in.	24 in.
30 in.	11.0 ft.	5.5 ft.	6.5 ft.	13 in.	7 in.	30 in.
36 in.	13.0 ft.	6.0 ft.	7.0 ft.	13 in.	7 in.	30 in.

Construction Questions Answered

How to Handle and Erect Bridge Girders Without Special Equipment—I

Transporting to site and erecting by protrusion.

Steel bridge spans up to a length of about 60 feet are almost always shipped to the site with the trusses or girders complete in single pieces or in two sections requiring only to be riveted together at the site. This is also frequently the case for spans up to 80 or 90 feet and under special circumstances may be the case for spans of 120 or 130 feet in length. Many of these spans are plate girders with solid steel webs to 10 feet in depth. Others are riveted trusses with the depth usually varying from 6 to 15 feet, which are also considered as girder spans. In any event they are completely fabricated at the bridge shops, where they are loaded on cars for shipment.

ERECTION BY FABRICATORS

Transportation, handling and erecting are separate matters that the bridge manufacturer may undertake, but which he does not generally wish to do, so that the erection of a bridge is often unduly expensive or slow if left to the convenience of the fabricator. A few contractors make a specialty of it and are provided with the necessary equipment for handling ordinary work.

Where competition can be secured or the site is not too remote or too much restricted by uncertain traffic problems and other uncertain conditions, it is generally better to have spans of more than 30 or 40 feet erected by the bridge company or a regular erector; but if this is not practicable, or if it appears that their charges are unduly high, it is generally possible to handle any girder spans, excepting, perhaps, very heavy ones for railroad traffic, by simple appliances within the reach of any general contractor and that do not involve a heavy special outlay.

ERECTION BY GENERAL CONTRACTOR

Highway spans of not more than 40 feet in length, for rural locations, may have a total steel weight up to 10 or 12 tons; their girders may weigh from 1 to 5 tons each and be from 2 to 5 feet in depth, and are riveted up complete before shipment.

For longer spans the girders will always be shipped separately, will have depths up to 10 or 15 feet and may have weights up to 20 or 30 tons each. In any event the spans can be unloaded and hauled to the site with the ordinary railroad facilities and by the use of locomotive cranes, derricks, gantries and jacking, cribbing and skidding operations as described in the article on highway bridge constructon, page 393, May 7th.

If the bridge is a highway span over a railroad track it can usually be delivered by the railroad and unloaded from it at low grade at some point very near the site and afterwards moved on rollers to the abutments and hoisted up to position without interfering with train service.

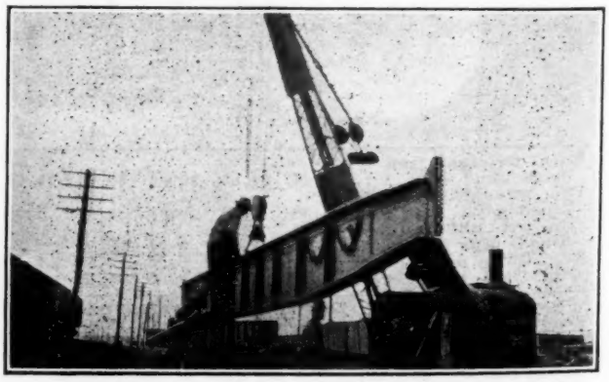
HAULING TO SITE

If the site is remote from the railroad the girders will have to be hauled, usually on special trucks or pairs of trucks, often suspended from the axles of special large wheel trucks so as to just clear the surface of the ground. Very deep girders are likely to be too large for clearance between the wheels and are loaded on bolsters on top of the trucks as shown in the picture of an 86-foot girder for a bridge 50 feet wide at Torresdale avenue over Frankford creek, Philadelphia. These girders weighed 39 tons each and were loaded on pairs of trucks with wide flange steel wheels and drawn by a tractor. They were hauled and erected by the fabricator, the American Bridge Company, that unloaded the heavy cross girders with a locomotive derrick.

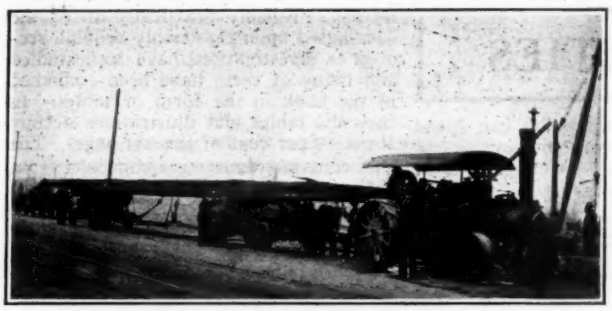
HANDLING A 40-TON PAIR OF GIRDERS

Some very interesting and ingenious work was done in the erection of the Wabash River bridge by a simple method and the use of equipment much too light to handle the bridge outright. This bridge has four spans each with two 20-ton plate girders 95 feet long and 8 feet deep. After being riveted up complete at the bridge shop, the girders of each span were temporarily clamped together in pairs 4 feet 8½ inches apart center to center.

The pairs of girders, weighing 80,000 pounds or more, were lifted by two 6,000-pound pneumatic hoists, one at each end, suspended from the roof trusses of the shop (this could have been accomplished in the field by substituting tackles or jackscrews for the hoists). The girders were balanced on cribwork near the middle, then one end was hoisted into an inclined position by one air hoist, then a second cribwork was built under them just beyond the center and the other pneumatic hoist was operated and easily rocked them over the new cribwork, raising that end the highest, the first cribwork was built up higher, and the girders rocked back on it, and so on alternately until both piles of blocking, one each side of the center, were carried up to support the girder higher than the floor of



UNLOADING BRIDGE GIRDERS BY LOCOMOTIVE CRANE AT SITE



HAULING GIRDER FOR TORRESDALE AVENUE BRIDGE

the flat cars which were run under both ends and to which the girders were lowered for shipment.

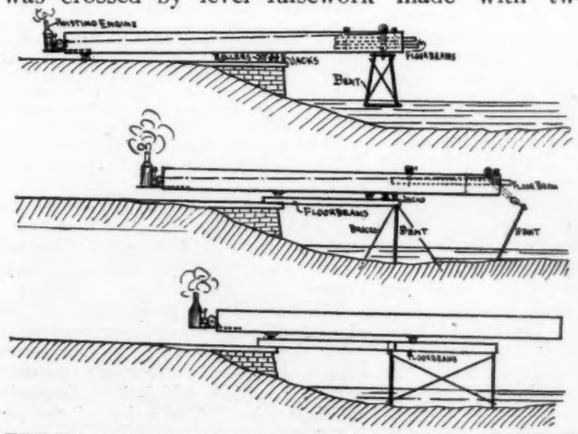
TRANSPORTING GIRDERS WITHOUT TRACKS

The railroad delivered these girders at a point half a mile from the bridge site. Here they were balanced on center fulcrum as before, and the ends were alternately lifted with light jackscrews so as to receive under the bottom flanges two pairs of rollers as shown in the diagram with 19-inch wheels having 9-inch faces and attached to bolted oak frames that had conections on top to hold them in place on the lower flanges of the girders. The wheels were built of oak blocks set between the flanges of a cast iron hub and bound with a steel tire 3/8 inch thick.

The rollers were placed about 35 feet from the ends of the girders. A platform was built on the ends of the girders and an ordinary hoisting engine mounted there, then a track of heavy timbers was built from the surface of the ground to the level of the car floor and supported by solid timber blocks. The girders were lowered down this track by hauling on a tackle anchored in advance and simultaneously slacking off on a preventer tackle in the rear.

TURNING THE GIRDERS

After reaching the ground level the girders were revolved 90 degrees on a turntable made with a 7-foot ring of 7/8-inch square steel, well greased and taking bearing on the lower flanges of the girders after the trucks were temporarily removed. Then the trucks were replaced and the bridge was hauled to the site by the hoisting engine and tackle, which was anchored to successive telegraph poles in advance of the girders. Slight curves were made easily and a five per cent grade down to the bridge was crossed by level falsework made with two lengths of floorbeams. Two-inch planks of green hard maple 10 inches wide were used for tracks.



ERECTING WABASH BRIDGE GIRDERS IN SPANS, BY PROTRUSION OVER FALSEWORK BENTS

ERECTING BY PROTRUSION WITH INTERMEDIATE SUPPORTS

On arrival at the bridge site the pair of girders was rolled out until it projected about a third of its length over the abutment. It was jacked up and supported by cribwork and blocking on top of the abutment, and from the end was suspended and set in place one framed bent of falsework.

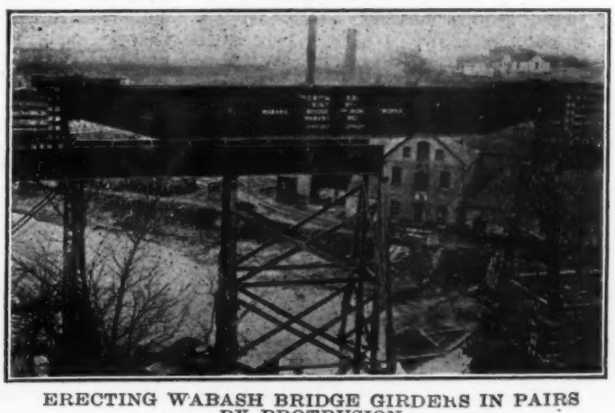
Two pairs of floor-beam girders had been suspended between the main girders near their upper edge and one pair of these was now lowered to bearing on them with their trucks and run forward another third of their total length until they again projected a third beyond the support.

They were again jacked up and another trestle bent set from the forward end and the remaining pair of floor-beams lowered into position in advance of the first ones upon the two trestle bents. The track was continued upon them and the main girders again lowered upon their trucks and advanced, this time being enabled to roll forward until the front end reached the pier.

LOWERING TO POSITION

They were then lowered to rest on cribwork at each end and the floor-beams and trestle bents removed from underneath. Then they were jacked down on greased skidrails and the clamps connecting the girders being removed they were slipped apart to the required positions and lowered to their permanent seats on the masonry after which the floor-beams and other members were connected to complete the span.

After this I-beams were laid across the floor-beams forming a longitudinal track upon which the second pair of main girders was run across to the pier and projected beyond it to set the trestle bents and temporary track, and were again advanced and the erection of this span completed like the first one. The third and fourth spans were similarly erected. The work was not done hurriedly and the time and labor occupied was as follows: five men jacked up the girders to remove them from the cars in 15 hours and in 10 hours more hauled them 150 feet to the turntable, after which 18 hours was required, half to haul them half a mile to the bridge site. In 12 hours 10 men carried the girders across from pier to pier and deposited them on the blocking. Two days were required to lower them to place and suspend the floor-beams on one span. One day and a half was required to spread them and another day to rivet them up.



ERECTING WABASH BRIDGE GIRDERS IN PAIRS BY PROTRUSION

NEWS OF THE SOCIETIES

Aug. 10-12—INTERNATIONAL ASSOCIATION OF STREET CLEANING OFFICIALS. Annual conference. Hotel La Salle, Chicago, Ill.

Aug. 23-25—AMERICAN ASSOCIATION OF PARK SUPERINTENDENTS Annual meeting. Detroit, Mich. Secretary, Emmet P. Griffin, Superintendent of Park, East St. Louis, Ill.

Aug. 30-Sept. 1—MICHIGAN STATE GOOD ROADS ASSOCIATION. Annual meeting. Flint, Mich.

Sept. 13-16—NEW ENGLAND WATER WORKS ASSOCIATION. 39th annual convention. Bridgeport, Conn. Secretary, Frank J. Gifford, 715 Tremont Temple, Boston, Mass.

Sept. 28 (10 days)—NEW YORK ELECTRICAL EXPOSITION. Seventy-first Regiment Armory, New York City.

Oct. 5-7—SOCIETY OF INDUSTRIAL ENGINEERS. National convention. Springfield, Mass.

Oct. 1-15—LYONS FAIR FOR PROMOTION OF INTERNATIONAL TRADE. Lyons, France.

Oct. 11-14—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Annual Convention, Atlanta, Ga. Hotel Ansley. Secretary, James J. Mulcahey, Municipal Building, Denver, Colo.

Oct. 24-28—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention. Southern Hotel, Baltimore, Md. Secretary, Charles Carroll Brown, Valparaiso, Ind.

Oct. 31-Nov. 5—NEW ENGLAND ASSOCIATION OF COMMERCIAL ENGINEERS. Power show in connection with INTERNATIONAL TEXTILE EXPOSITION. Mechanics' Building, Boston, Mass. Secretary, James F. Morgan, Devonshire st., Boston.

Nov. 14-18—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting. New York City.

ENGINEERS' ASSOCIATION OF FAIRFIELD COUNTY, CONN.

At its fifth annual dinner on June 2, this association was addressed by Nelson P. Lewis, formerly chief engineer of the Board of Estimate and Apportionment, New York, on "Scientific City Planning," F. B. Bartram, president of the Stamford, Conn., Chamber of Commerce, on "Stamford's Future Possibilities in Industries," and Rev. A. G. Walton on "Engineers as Influential Citizens."

GREAT LAKES, HUDSON & ATLANTIC WATERWAYS ASSOCIATION

The first convention of the Great Lakes, Hudson & Atlantic Waterways Association was held at Buffalo on June 29-30. Fullest use of the New York State Barge Canal, as opposed to the St. Lawrence waterway project, was urged at this meeting, which was addressed by Henry Moskowitz, chairman of the new association, P. H. W. Ross, of the National Marine League, Charles L. Cadle, superintendent of the New York State Department of Public Works, Frank M. Williams, and many others.

ENGINEERING OUTINGS

Now, while engineering construction is so slack, and especially while it is hard to promote new enterprises during the vacation time, the members of local organizations of engineers, contractors and officials should improve the opportunity for informal gatherings that will promote friendships, mutual appreciation and open the way for future amenities. Members and guest meeting at headquarters with a few automobiles can spend a few hours on many pleasant social trips and incidentally be welcomed at points of technical interest.

PERSONALS

Maxwell, W. D., has been reappointed engineer of Sac county, Iowa.

Morse, Fred S., has been appointed city engineer of Springfield, Ill.

Leventon, H. L., superintendent of the Placerville-Lake Tahoe unit of the Lincoln highway, has been appointed assistant engineer and assigned to the Sacramento division of the California State Highway Department.

Hengst, N. C., has been appointed engineer of the Barry county, Michigan, road commission.

Torras, R. W., has been appointed to the city planning commission of Atlanta, Ga.

Clark, F. M., is construction engineer for the Maine highway commission.

Chase, Clement E., has been appointed principal assistant engineer of the Delaware River Bridge Joint Commission with headquarters in Philadelphia, Pa.

NEW CIVIL ENGINEERING FIRM

Maj.-Gen. W. M. Black, U. S. A., retired, Charles A. McKenney and John Stewart, formerly president and treasurer of the Cranford Construction Co., Cincinnati, Cleveland and Pittsburgh, announce the formation of the engineering firm of Black, McKenney & Stewart, for consultation, organization, administration, river and harbor, port and terminal, municipal and highway engineering, investigations and surveys, reports and designs. Office at 618 17th street N. W., Washington, D. C.

BOOK REVIEW

COLLECTION AND DISPOSAL OF MUNICIPAL REFUSE

For ten years past there has been in preparation a book on refuse collection and disposal by Rudolph Hering, with whom later Samuel A. Greeley collaborated, and the result has just been published by the McGraw-Hill book company. There can be no question that this is the most complete and authoritative work on this subject which has yet appeared in this country. The high standing of both of the authors is guarantee of the reliability of the information given. Dr. Hering has been prominently identified with refuse disposal since serious attention first began to be paid to it in this country and, in fact, did much to stimulate the discussion and investigation of the subject and development of modern methods.

In the preparation of this book the authors have consulted comparatively all of the literature on the subject published in this country and much of that published in Europe as well; the majority of this being in the form of reports of investigations and of the annual operation of municipal departments. Probably practically all of the data based upon reasonably reliable records or investigations have been studied and many of them have been embodied in the book in the form of tables. In fact, the tables and illustrations occupy about 40 per cent of the 634 pages. The text contains numerous quotations from the more important reports on the subject treated of. There are given a considerable number of cost records, most of them pertaining to the period before the war; however, the date to which the costs refer is given in most cases, which is very essential considering the very great effect of the war upon all cost records.

The seventeen chapters refer to "Refuse Materials," "House Treatment," "Collection," "Supplemental Transportation," "Estimating the Cost of Collection and Transportation," "Outline of Methods of Final Disposal," "Depositing in Water and on Land," "Feeding Garbage to Hogs," "Sorting Rubbish," "Incineration of Refuse," "Reduction of Garbage," "Estimating Costs of Final Disposal," "Stable Refuse," "Street Refuse," "Night Soil and Dead Animals," "Procedure in Small Towns and Villages."

The treatment of the chapters is uniform throughout in that facts and figures are given concerning different cities or as derived from different authorities, including such tables and other data as were available and seemed fairly reliable; and at the end of each chapter is a brief "summary," "conclusion," or "summary and conclusion." These summaries and conclusions occupy less than a page in practically every case. The twelve or fifteen pages which would be occupied by these if combined in one section form an excellent brief resume of the information given in the book, but, of course, in this brief space only the barest outline or general statement of the subject can be made. For instance, under the subject of house treatment the summary and conclusion are as follows:

> The details of the house treatment of refuse discussed in this chapter should serve to show and to emphasize its importance: Specific conclusions pertaining to all conditions cannot be drawn. It is necessary to study this subject carefully, together with a consideration of the organization and routine work of the collection department. The relation of the house treatment of the collection service and final disposal requires more attention in its details than has heretofor been given to it; and, to secure the best treatment, the complete co-operation of the householders and the department is necessary. This can be obtained only by patient, persistent and intelligent inspection, as well as guidance, on the part of the officials of the department.

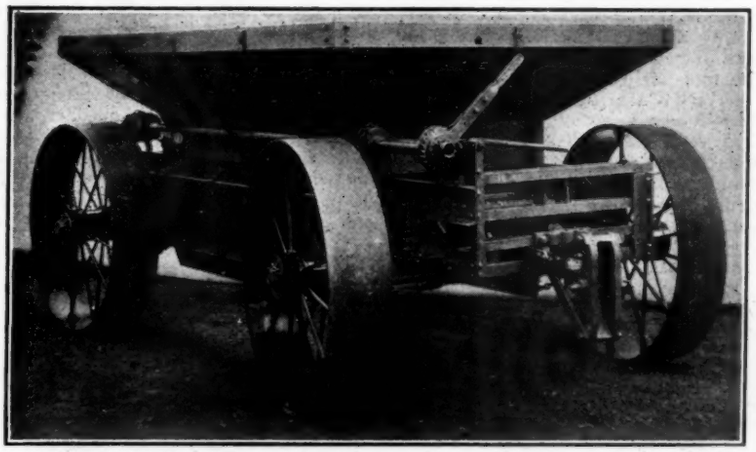
This serves as the summary of a chapter which occupies twenty-three pages.

The longest chapters are those dealing with "Collection," "Incineration of Refuse" and "Reduction of Garbage," these occupying 67, 131 and 56 pages, respectively.

The book is profusely illustrated with photographs of receptacles, wagons, incinerating and reduction plants, garbage dumps and other features connected with the subject which lend themselves to illustration. The price of the book is $7 net.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations



REVERSIBLE BOTTOM DUMP TRAILER MODEL MR-3, WEIGHT 4,050 POUNDS

MIAMI TRAILERS

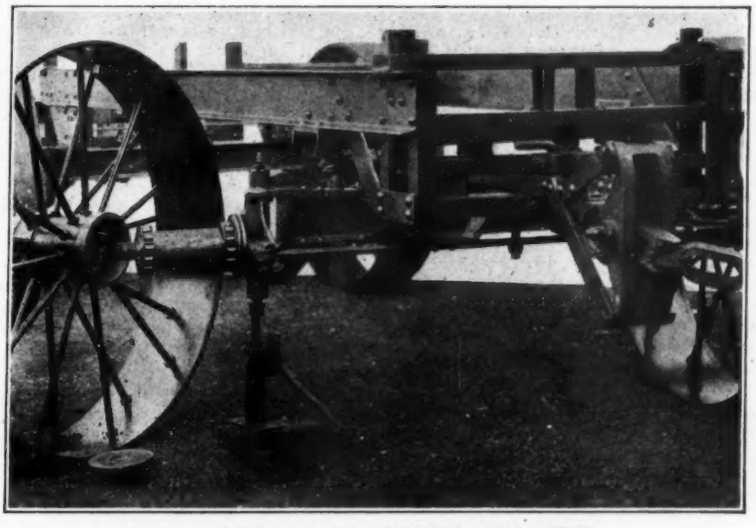
The Miami Trailer Co. is equipped with 8 years of successful manufacturing experience and a large modern factory devoted to the production of trailers of various sizes and patterns for commercial and construction operations. They are built in 14 or more models with capacities of 1,000 to 12,000 pounds. The 4-wheel trailers have draw-bar connections to two points of the front axle, at each end, and the front axle is connected through a reach to five points of the rear axle, relieving the frame and springs of all pull. The steering gear has only two wearing parts, both of them in the fifth wheel where they cannot affect the steering.

The trailer construction on the 3-point suspension system enables either front wheel to drop into a rut without rocking or straining the frame under the load The different models of trailers are equipped with platforms and various styles of bodies. Model No. 126, of 12,000 pounds capacity has a 14-foot coupling pole, artillery wheels, two sets of bolsters, one for the truck and one for the trailer, a heavy cast steel ball hitch, and weighs 4,000 pounds.

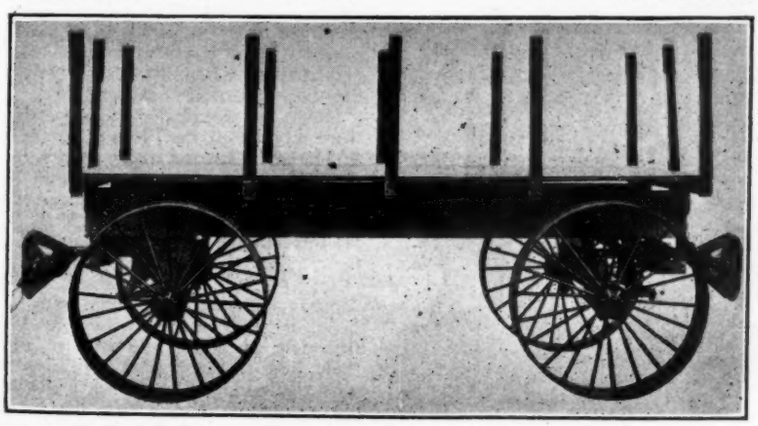
The pipe trailers are built especially to withstand unusually severe strains and rough service, and the parts are oversize, and overstrength with a margin of safety of 100 to 700 per cent at all vital points. The frame construction is designed to form a very strong boxing for the pole and thus eliminates the necessity for balancing the load. The cast steel bolster dogs are built to withstand the great weight of 30 tons and are easily adjustable to any positions on the swinging bolsters to which they are secured by a positive locking device independent of the weight of the load. The Miami hitch is semi-automatic in action, and so flexible that the trailer can be turned through a 45-degree angle without binding. It has a sheering strength at the pin of 60 tons, it contains no small parts and can be quickly connected.

Model No. 123 has artillery type wheels, a 60-inch bolster, tracks 56 inches, and weighs 2,000 pounds crated, while the 126 model has a rated capacity of 6 tons, and weighs 3,200 pounds. Both of them and the intermediate size take loads from 10 to 35 feet long.

The latest additions to the list are two reversible slow-speed trailers of the bottom-dump type with section stake bodies for hauling general freight. The model MR-3 has a wheel base of 7 feet 8 inches, 11 feet 1 inch x 42-inch chassis frame, 10 gauge reinforced steel bottom doors, 5-inch I-beam axles, dust and waterproof hubs, high pressure lubrication, and a capacity of 3 cubic yards water measure or 10,000 pounds, and a weight of 4,000 pounds



DETAILS OF CHASSIS AND AXLE



REVERSIBLE PLATFORM TRAILER MODEL MR-3-H WEIGHT 3,600 POUNDS

GRINNELL SPRINKLERS

The advantages of the new Grinnell sprinkler system for fire protection in low-water-pressure cities, are demonstrated in the Grinnell Bulletin for July, where it is said that in New York, Chicago, Philadelphia and Detroit alone there are many millions of dollars' worth of property that have been denied the benefit of sprinkler protection on account of the low pressure of the city water supply and the cost of introducing auxiliary elevated tank supply.

To solve this difficulty the Grinnell improved booster pump sprinkler system, in which an automatic electric pump is utilized to build up any required pressure and maintain it indefinitely is described. The pumps of the new system are practically the same as those of any single source sprinkler system supplied by city water, except that the whole pump unit is cut into the system between city connection and the main riser, the capacity of the pumps being determined by the size, construction and contents of the building to be protected. The pump takes suction directly from the water main. builds up the pressure into sprinkler system of the required amount and stops working, automatically, resuming operation as soon as built up pressure falls appreciably anywhere in the system.

Where the American District Telegraph Supervisory Service is available every one of the Grinnell improved systems can be periodically operated by means of a special valve and certain supervisory instruments demonstrating the prompt operations and the condition of the apparatus.

STAMP TRUCKMIXER

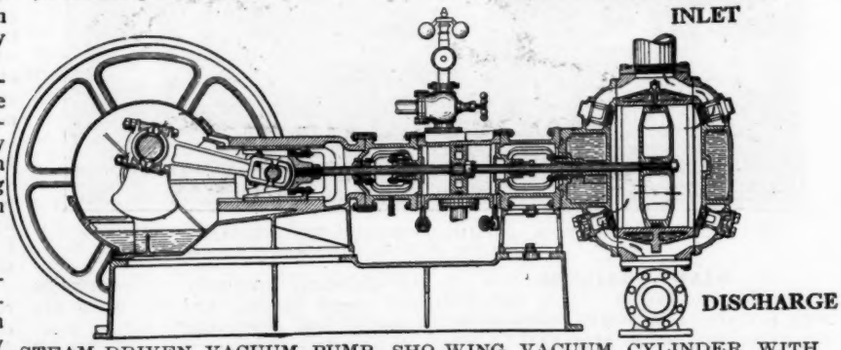
The Stamp Truckmixer, manufactured by the Truckmixer Co., is a concrete mixer mounted on a truck in place of the truck body. The ordinary batch body with its hoist is replaced with a specially constructed frame which fastens onto the chassis and supports a concrete mixing drum. The power formerly used to operate the hoist is transferred to the drum, making a direct and efficient drive.

The entire mixer, with its mechanism, has fewer parts than the ordinary dump body and hydraulic hoist. Stone, sand, cement and water are put into the drum direct from bins and the truck is hauled to the site for concreting roadway or other structures. Mixing is preferably done on the final stretch, just before discharging. When it arrives at the place of laying the concrete, the truck is turned around and backed up—the mixed batch is discharged by gravity into a chute which delivers the material to the rear of the truck, and as it moves forward, the chute spreads the concrete so that only a minimum of hand spreading is necessary.

The Truckmixer eliminates the paving mixer, with its crew of wheelers and operators. It takes considerably less time to discharge the mixed concrete than to dump two or three batches into the mixer skip. There is no mixer to limit the output and even if the length of haul is reduced, the trucks can make more trips.

DRY VACUUM PUMPS

The double cylinder, steam and belt driven WA-61 and WG-61 dry vacuum pumps manufactured by the Sullivan Machinery Co. are built in capacities ranging from 300 to 1,600 cubic feet displacement per minute.



STEAM-DRIVEN VACUUM PUMP, SHO WING VACUUM CYLINDER WITH WHICH SOME SIZES ARE PROVIDED

One of their principal features is the Sullivan improved wafer type valve. It is compact, low in lift, lignt in weight, indestructable, requires no attention, is noiseless in operation, and functions under exceedingly low pressures.

The pumps are built on the interchangeable part system, and are of the center crank pattern with main bearings, crank shafts and fly wheels at one end and steam and vacuum cylinders at the opposite end. The vacuum cylinder, barrel, and head, are completely surrounded by water jackets. The valves are employed in multiples of relatively small size and the vacuum cylinder is lubricated by a high grade sight feed cylinder lubricator, which will contain enough oil for several days' run. The pumps are either belt driven, steam driven, simple or duplex, and are made in 13 different sizes and patterns, with displacements of 610 to 2,200 cubic feet per minute.

HOISTS FOR TUNNEL SHAFTS

The S. Flory Manufacturing Company, Bangor, Pa., supplied five electrically driven shaft hoists for the Shandaken tunnel. These hoists are specially designed for shaft operation and are of the same type as those supplied by the Flory Co. to a number of other contractors on the Catskill Aqueduct work for shafts on tunnel contracts. Two of these hoists have drums 54 inches in diameter and 66 inches long ,while three of them have drums 54 inches in diameter and 48 inches long, the length of the drum being determined by the depth of the shafts. The drums are keyed to the shafts and bolted to the gears. Each drum is equipped with two differential brake bands lined with asbestos blocks so connected that one of the bands has contact in each direction of rotation, both of them handled through one operating lever, which is inserted in a notched quadrant with thumb latch. The hoists with the smaller drums are driven through 112 h. p. motors and those with the larger drums through 150 h. p. motors, the motors being General Electric make, type ITC, reversing and equipped with drum controllers of the semi-magnetic type.

An important feature of the hoist construction is in the design of the drum bearings. The ribs of these bearings are heavily reinforced, and the bearing cap has a slot machined in same over which there is fitted a heavy steel U bolt which passes over the slot and through the body of the bearing housing down into the concrete foundation. The object of this type of construction is to maintain perfect drum shaft alignment, as the principal stress is the tendency to lift the shaft out of its bearing.

Hoists of practically the same design were supplied by the Flory Co. to Mason & Hanger Co. for their contracts on the Moodna tunnel, their New York City pressure tunnel, Pittsburgh Contracting Co. for their New York City pressure tunnel, Oscar Daniels Co. for their Cornwall tunnel and Flynn-O'Rourke Co. for the shafts on the Montague Street East River tunnel.

All of these hoists were operated continuously 24 hours a day and finished their jobs in such good condition that most of them have been sold to coal mining companies throughout the country and are now installed in these mines handling coal.

MIXING CONCRETE DURING TRANSP ORTATION, USING AUTOMOBILE EXCESS POWER